TECHNO-ECONOMIC FEASIBILITY REPORT

Airport at Jewar

ABSTRACT

Techno-economic feasibility study for the development of greenfield airport at Jewar, Uttar Pradesh

By

PricewaterhouseCoopers Private Limited for Yamuna Expressway Industrial Development Authority

Disclaimer

The report has been prepared by a consortium led by PricewaterhouseCoopers Pvt. Ltd (PwC) for Yamuna Expressway Industrial Development Authority (YEIDA). The technical master plan for the proposed Jewar Airport has been prepared by Meinhardt Singapore Pte. This is pursuant to the Scope of Work under the Letter of Engagement executed between PwC and YEIDA (January 2018). PwC has been appointed by YEIDA to undertake feasibility study for Greenfield airport at Jewar, Uttar Pradesh. This document has been prepared solely for YEIDA, being the express addressee to this document. PwC does not accept or assume any liability, responsibility or duty of care for any use of or reliance on this document by anyone, other than (i) YEIDA, to the extent agreed in the relevant contract for the matter to which this document relates (if any), or (ii) as expressly agreed by PwC in writing in advance. Any third party should obtain prior consent of PwC before copying or reproducing, in whole or in part, the contents of this report. PwC disclaims any responsibility for any loss or damage suffered by any third party by taking reliance of this report. Furthermore, PwC will not be bound to discuss, explain or reply to queries raised by any agency other than the intended recipients of this report.

PwC does not accept any liability or responsibility for the accuracy, reasonableness or completeness of, or for any errors, omissions or misstatements, negligent or otherwise and does not make any representation or warranty, express or implied, with respect to the information contained in this document. The information contained in this document is selective and is subject to updating, expansion, revision and amendment. It does not, and does not purport to contain all the information that a recipient may require. Further this is not an audit report and no reliance should be based on this report for the purposes of audit.

Contents

List of tables **8**
List of figures **10**
List of abbreviations **12**
1. Executive Summary **15**
2. Introduction **23**
2.1. General 23
2.2. Scope of the study 23
2.3. Project site 24
2.4. Topography and site condition 28
2.5. Existing connectivity infrastructure 30
3. Trends in aviation sector **33**
3.1. Global aviation sector trends 33
3.2. Aviation trends in India 35
3.2.1. Aviation trends in Delhi NCR 40
4. Potential traffic at Jewar **43**
4.1. Approach and methodology 43
4.2. Module 1: Overall demand and distribution 45
4.2.1. Hinterland demand estimation 46
4.2.2. Hinterland identification and distribution 48
4.3. Module 2: Passenger preference 51
4.3.1. Unconstrained demand at the airports 55
4.4. Module 3: Supply side constraint 57
4.4.1. Capacity at IGIA 57
4.4.2. OD pairs and minimum threshold traffic requirement 60
4.5. Connectivity to the airport 64
4.5.1. Connectivity Projects for hinterland connectivity 64
4.5.2. Connectivity to enable spillover from Delhi 65
4.6. Regional connectivity scheme 70
4.6.1. About the scheme 70
4.6.2. Impact of RCS on traffic at Jewar 71
4.7. Total Traffic Estimates 73
5. Cargo potential **74**
5.1. Cargo traffic at IGI Airport 74
5.2. Cargo potential at Jewar 77
5.3. Overall hinterland demand 77

5.4. Cargo demand at Jewar 79
6. Non-aeronautical revenue 86
6.1. Importance of non-aeronautical revenue 86
6.2. Factors impacting non-aeronautical revenue potential 87
6.3. Trends observed at PPP airports 89
6.4. Non-aeronautical revenue potential at Jewar Airport 92
7. City side and MRO 94
7.1. Off-take pattern at other PPP airports 94
7.2. Commercial development opportunity at Jewar 94
7.2.1. MRO facility 94
7.2.2. Other commercial facilities 98
8. Master planning 100
8.1. Planning philosophy 100
8.2. Planning norms 101
8.3. Airport facility requirements 103
8.3.1. Traffic, fleet mix, and design capacity 103
8.3.2. Airport classification 107
8.3.3. Siting, orientation, and number of runways 108
8.3.4. Obstacle Limitation Surfaces (OLS) 108
8.3.5. Airfield safety requirements 110
8.3.6. Number of runways 110
8.3.7. Taxiways 112
8.3.8. Holding bays 116
8.3.9. Aprons 118
8.4. Passenger terminal development 123
8.4.1. Terminal planning approach 124
8.4.2. Assumption and planning criteria 125
8.4.3. Terminal flows 126
8.4.4. Terminal phasing 130
8.4.5. Passenger terminal surface area requirements 130
8.5. Air cargo development 132
8.5.1. Planning approach 132
8.5.2. Air cargo facility requirements 133
8.6. Air Traffic Control Tower 134
8.6.1. Aerodrome ground lighting 135
8.7. Airside roads 136
8.8. Operational walls 136
8.9. Airside access gate 136
8.10. Isolation bay 136

8.11. Bomb cooling pit 136
8.12. Drainage 137
8.13. Landside development 138
8.14. Proposed external connectivity 139
8.15. Landside traffic forecast 140
8.15.1. Daily traffic 140
8.15.2. Passenger traffic parameters 140
8.15.3. Peak traffic 142
8.15.4. On site facility requirement 143
8.15.5. Access roads 143
8.15.6. Parking demand 143
8.15.7. Forecourt 144
8.16. Support facilities 144
8.16.1. Fueling facilities 145
8.16.2. MRO facility 146
8.16.3. GSE maintenance 147
8.16.4. Flight kitchen (in-flight catering) 147
8.16.5. Air rescue and fire fighting 147
8.16.6. Meteorological/ IMD facilities 147
8.16.7. Authority facilities 148
8.16.8. Customs facility 148
8.16.9. Animal Quarantine Services 148
8.16.10. Airport maintenance building 148
8.16.11. Airport offices and administration building 148
8.16.12. Airport Health Organization 148
8.17. Utilities 149
8.17.1. Power 149
8.17.2. Energy efficient lighting 150
8.17.3. Water supply 150
8.17.4. Sewage 151
8.17.5. Solid waste 152
8.17.6. Aircraft waste 152
8.18. Other facilities 152
8.18.1. Police aid post 152
8.18.2. Police station 152
8.18.3. Security check points 152
8.19. Communication systems 153
8.20. Airport development phasing 153
8.21. Implementation plan 154

9. Capital expenditure (CAPEX) profiling 162
9.1. CAPEX profiling 162
10. Operating expenditure 166
10.1. Staff cost 166
10.2. Utilities 167
10.2.1. Electricity 167
10.2.2. Water 167
10.3. Repair, operations, and maintenance 167
10.3.1. Repair and maintenance 167
10.3.2. Consumables and spare 168
10.4. General administration and others 169
10.5. Total operating expenditure 169
11. Financial Assessment 170
11.1. Key assumptions of the financial assessment 170
11.1.1. Key dates 170
11.1.2. Traffic 170
11.1.3. Macroeconomic Assumptions 171
11.1.4. Capital investment phasing 171
11.1.5. Terms of the Debt 172
11.1.6. Other assumptions 173
11.2. Key outcomes of the financial assessment 174
11.2.1. Nominal Capital investment and phasing 174
11.2.2. Means of Finance 175
11.2.3. Economic Regulation and tariff card 176
11.2.4. Financial Viability assessment 182
12. Economic IRR 187
12.1. Conclusion 191
Appendix A. - Hinterland 192
A.1. Districts in the hinterland (GDP and population) 192
Appendix B. - IGI Airport 194
B.1. Traffic patterns (domestic) 194
B.2. Traffic patterns (international) 196
B.3. ATM movement pattern at IGIA (scheduled operations) 198
B.3.1. Overall weekly movement 198
B.3.2. Overall domestic movement 199
B.3.3. Overall international movement 200
Appendix C. - Regression for traffic forecast 201
C.1. Regression for domestic traffic 203
C.2. Regression for international traffic 204

C.3. Regression for air cargo 205
Appendix D. - Total demand for air travel 207
D.1. Total hinterland demand and demand profile 207
Appendix E. - Demand allotment 211
E.1. Allotment of districts to airport (s) 211
Appendix F. - Origin-destination pair feasibility at Jewar Airport 215
F.1. International destinations 215
F.2. Domestic destinations 216
Appendix G. - Final demand at Jewar Airport 217
G.1. Breakup of demand at Jewar 217
Appendix H. - Upcoming investments in electronics in Gautam Buddh Nagar 219
Appendix I. - Financial assessment 221
I.1. Detailed list of assumptions – Financial Assessment 221
I.1.1. Depreciation 221
I.1.2. Distribution between aeronautical and non-aeronautical assets, revenues and costs 222
I.1.3. Aeronautical Revenue 225
I.1.4. Economic IRR 227
Appendix J. - Survey conducted at IGIA 231
Appendix K. - Final masterplan 235
Appendix L. - Masterplan layout with extension 236
Appendix M. - Phase I layout 237
Appendix N. - Phase II layout 238
Appendix O. - Phase III layout 239
Appendix P. - Phase IV layout 240
Appendix Q. - Land area layout 241

List of tables

Table 1: Cargo Projections for Jewar Airport 17
Table 2: Peak hour handling requirement 19
Table 3: Development phases for Airport at Jewar 19
Table 4: Summary of aviation sector trends, historical growth rates 41
Table 5: Comparison between RRTS & normal metro 66
Table 6: Cargo forecast for hinterland 78
Table 7: Historical cargo growth rate 79
Table 8: Cargo traffic forecast for Jewar 83
Table 9: Cargo growth rates at Jewar 85
Table 10: Comparison of non-aeronautical revenue breakup for select airports (INR) 90
Table 11: Overview of airlines in India and their MRO contracts 96
Table 12: Potential areas for commercial use 98
Table 13: Estimation of peak hour passenger and aircraft handling demand at Jewar airport 103
Table 14: Fleet mix expectations at Jewar Airport 104
Table 15: Development phases for Jewar Airport 106
Table 16: Air traffic forecast at Jewar Airport 107
Table 17: Summary of hourly capacity by runway configuration and mode of operation 111
Table 18: Number of runways recommended 112
Table 19: Taxiway minimum separation distances 114
Table 20: Location of rapid exits in relation to the ICAO aircraft category 115
Table 21: Number and characteristics of the rapid exits 115
Table 22: Minimum Clearance Distances in a Holding Bay (F code) 117
Table 23: Number of Passenger Aircraft Positions per ICAO Aircraft Code 123
Table 24: Required Apron Surface per ICAO Aircraft Code 123
Table 25: Apron Surface Requirements 123
Table 26: Indicative phasing, by capacity 130
Table 27: Processing area assumptions 130
Table 28: IMG norms 131
Table 29: Terminal space requirement 132
Table 30: Cargo warehouse requirement 134
Table 31: Cargo apron requirement 134
Table 32: Adopted parameters for employee/visitor estimation 140
Table 33: Modal split (%) for person trips – passengers/escorts (domestic) 141
Table 34: Modal split (%) for person trips – passengers/escorts (international) 141
Table 35: Modal split (%) for person trips – employees 142
Table 36: Average vehicle occupancy 142
Table 37: Expected peak passenger traffic on access roads, PCUs 143
Table 38: Expected peak cargo traffic on access roads, PCUs 143
Table 39: Passenger vehicle parking requirement 144
Table 40: Fuel farm facility requirements 146
Table 41: R& M cost benchmark 168
Table 42 - Traffic at Jewar airport under base case 171
Table 43 – Phase wise construction trigger assumptions 172
Table 44: Real and nominal capital investment (including IDC capitalization) for different phases 174
Table 45: Investment phasing based on the traffic trigger 174
Table 46 – Means of Financing for Jewar airport 175
Table 47: Coverage ratios 182
Table 48: Sensitivity and demand variation 185
Table 49: Sensitivity and variation of parameters 185

Table 50:GDP and Employment multiplier by country 189
Table 51: Information on districts in the core hinterland 192
Table 52: Breakup of IGIA's domestic traffic, by destination 194
Table 53: Breakup of IGIA's international traffic, by destination 196
Table 54: ANOVA table for International cargo regression 205
Table 55: ANOVA table for domestic cargo regression 206
Table 56: Breakup of final demand at Jewar Airport, million passengers handled annually 217
Table 57: Overview of the survey sample 231

List of figures

Figure 1: Non-aeronautical revenue per passenger (INR, Real terms) 18
Figure 2: Location of the proposed airport 25
Figure 3: Proposed site for Jewar Airport 26
Figure 4: Land acquisition for Jewar Airport 27
Figure 5: Airport site on Google Earth 28
Figure 6: Longitudinal Profile of Airport site 28
Figure 7: Transverse Profile of Airport site 29
Figure 8: Airport site on topo-sheet 29
Figure 9: Physical Features of Airport 30
Figure 10: Proposed transport network around Jewar Airport site 31
Figure 11: Railway connectivity to the proposed site 32
Figure 12: Passengers carried via air transport globally, in billion 33
Figure 13: Freight transported by air globally, billion ton-km 34
Figure 14: World GDP growth projections (CAGR for 2016- 2036), by region 34
Figure 15: Number of expected deliveries by Boeing (2017- 2036), by region 35
Figure 16: Air traffic in India, million passengers handled 36
Figure 17: Difference in percentage growth rates of passenger air traffic and GDP, for India 36
Figure 18: Total cargo handling at airports in India, thousand tons annually 38
Figure 19: Passenger handling at Indian airports, share by city (2016-17, annual) 38
Figure 20: Air traffic at IGI Airport, million passengers handled annually 40
Figure 21: Air cargo handling at IGI Airport, thousand tons annually 41
Figure 22: Approach and methodology for passenger traffic estimation at proposed Jewar Airport 43
Figure 23: Hinterland of the dual airport system 45
Figure 24: Demand for domestic air travel from the hinterland, million passengers handled annually 47
Figure 25: Demand for international air travel from the hinterland, million passengers handled annually 47
Figure 26: Hinterland catered by IGI airport 48
Figure 27: Hinterland movement: domestic passengers (left) and international passenger (right) 49
Figure 28: Expected distribution of hinterland traffic generation in 2018-19 49
Figure 29: Foreign tourist arrivals, share of districts in total footfall 50
Figure 30: Travel time from hinterland's districts to Jewar 52
Figure 31: Travel time from hinterland's districts to IGIA 52
Figure 32: Distance from hinterland's districts to Jewar, in km 53
Figure 33: Distance from hinterland's districts to IGIA 53
Figure 34: Time and distance analysis of Gautam Buddh Nagar District 54
Figure 35: Allocation of core hinterland districts to airport(s) 55
Figure 36: Unconstrained demand for passengers at Jewar Airport, million annually 56
Figure 37: Aircraft and passenger movement pattern at IGIA on a typical day 57
Figure 38: Pattern of traffic spill from IGIA to Jewar 58
Figure 39: Demand increase (incremental) at IGIA and year on year spill over to Jewar 59
Figure 40: Concept of Origin-Destination threshold filter 60
Figure 41: Distribution of traffic across different cities 61
Figure 42: Feasible domestic destinations from Jewar 62
Figure 43: Feasible international destinations from Jewar 63
Figure 44: Routes planned by NCRTC 66
Figure 45: Options for RRTS routes (1 and 2) 67
Figure 46: Connectivity option (3) 68
Figure 47: Distribution of air traffic across different districts of NCT of Delhi 69
Figure 48: Capacity deployment under RCS (Phase I) destinations for Delhi, weekly one way (total seats) 71
Figure 49: RCS based traffic potential in NCR region 72

Figure 50: RCS based traffic potential at Jewar Airport 72
Figure 51: Final demand for traffic at Jewar Airport 73
Figure 52: Historical cargo at IGI Airport (million tons)....74
Figure 53: IGI airport hinterland 75
Figure 54: Cargo movement at IGI....76
Figure 55: Domestic cargo details 76
Figure 56: Hinterland for Jewar airport 80
Figure 57: Future investments in the region....81
Figure 58: International cargo origin centers in future 81
Figure 59: OD pair for international cargo 82
Figure 60: Domestic ATM split between IGI and Jewar....83
Figure 61: Share of aeronautical and non-aeronautical revenue at Indian airports 86
Figure 62: Share of aeronautical and non-aeronautical revenue at international airports 87
Figure 63: Dwell time at airports, by passenger type....88
Figure 64: Time spent by Indians at airports (hours)....88
Figure 65: Revenue breakup at select airports in India 89
Figure 66: Non-aeronautical revenue for major Indian airports (INR per passenger)....89
Figure 67: Breakup of non-aeronautical revenue at Delhi and Mumbai airports 90
Figure 68: Non-aeronautical revenue trends at Hyderabad Airport....92
Figure 69: Traffic profile at Jewar....92
Figure 70: Category of services at Jewar....93
Figure 71: Non-aeronautical revenue per passenger 93
Figure 72: Existing and projected MRO market arising out of India (billion USD) 95
Figure 73: Number of aircrafts available for MRO services in India (considering expiry of existing MRO contracts)....97
Figure 74: Geographical spread of the airport area 100
Figure 75: Phase I plan....156
Figure 76: Phase II plan 158
Figure 77: Phase III plan....159
Figure 78: Phase IV plan....160
Figure 79: Key parameters at Indian airport 166
Figure 80: Staff employed by range of traffic 167
Figure 81: Breakup of R&M cost....168
Figure 82: Consumables and spares as a percentage of R&M costs....168
Figure 83: Operating cost per passenger (real terms)....169
Figure 84: Regulatory Regime for tariff determination in India....177
Figure 85 – Yield and UDF at PPP airports in India 180
Figure 86 – Aeronautical Yield breakup for Jewar airport based on revised tariff card....182
Figure 87 – CFADS vs Debt Service 183
Figure 88: Economic benefit of airport infrastructure....188
Figure 89: Air traffic movement pattern at IGIA (overall) 198
Figure 90: Air traffic movement pattern at IGIA (domestic) 199
Figure 91: Air traffic movement pattern at IGIA (international) 200
Figure 92: Traffic forecasting methodology, ICAO....201
Figure 93: Datasets and methods considered for regression....202
Figure 94: International cargo regression curve 205
Figure 95: Domestic cargo regression curve....205
Figure 96: Demand distribution across the hinterland (international traffic) 232
Figure 97: Demand distribution across the hinterland (domestic traffic) 233
Figure 98: Split of hinterland demand, by hinterland region and origin/destination city....234

List of abbreviations

Abbreviations	Full form
AAI	Airports Authority of India
ADSCR	Average Debt Service Coverage Ratio
AERA	Airports Economic Regulatory Authority of India
AGL	Airfield Ground Lighting
AOCC	Airport Operations Control Centre
ARR	Average Revenue Requirement
AMSL	Above mean sea level
ATF	Aviation Turbine Fuel
ATM	Air Traffic Movement
BIAL	Bangalore International Airport Ltd
BMS	Baggage Management System
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CAPM	Capital Asset Pricing Model
CFADS	Cash Flow Available for Debt Service
CIS	Commonwealth of Independent States
CPI	Consumer Price Index
CUTE	Common User Terminal Equipment
DGCA	Directorate General of Civil Aviation
DGPS	Differential Global Positioning System
DIAL	Delhi International Airport Ltd
DIZ	Direct Impact Zone
DSCR	Debt Service Coverage Ratio
DSRA	Debt Service Reserve Account
DVOR	Doppler VHF Omni Directional Range
E&M	Electrical and Mechanical
FGD	Focus Group Discussion
FY	Financial Year
GDP	Gross Domestic Product
GST	Goods and Service Tax
HIAL	Hyderabad International Airport Ltd
HVAC	Heating, Ventilation and Air Conditioning
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IDC	Interest During Construction
IGIA	Indira Gandhi International Airport
IMF	International Monetary Fund
INR	Indian Rupee
IRR	Internal Rate of Return

Abbreviations	Full form
JV	Joint Venture
KWH	Kilowatt Hour
LLCR	Loan Life Coverage Ratio
LPH	Landing Parking and Housing charges
MET	Meteorological
MIAL	Mumbai International Airport Ltd
MPPA	Million Passengers Per Annum
MRO	Maintenance Repair and Overhaul
MSSR	Monopulse Secondary Surveillance Radar
MT	Metric Ton
MTOW	Maximum Takeoff Weight
NCAER	National Council of Applied Economic Research
NCAP	National Civil Aviation Policy 2016
NCR	National Capital Region
NCT	National Capital Territory
NITI Aayog	National Institution for Transforming India
O&M	Operation and Maintenance
OD	Origin-Destination
OECD	Organization for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
OPEX	Operating Expenses
PAH	Project Affected Households
PAP	Project Affected Person
PAX	Passenger
PIA	Project Influence Area
PPP	Public Private Partnership
R&M	Repair and Maintenance
RAB	Regulatory Asset Base
RCS	Regional Connectivity Scheme
RESA	Runway End Safety Area
RFCTLARR Act	Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act
ROI	Return on Investment
SIA	Social Impact Assessment
SPV	Special Purpose Vehicle
SQ M	Square Meter
SSC	Secondary School Certificate
TEFR	Techno Economic Feasibility Report
U.P.	Uttar Pradesh
UDF	User Development Fees
UNWTO	World Trade Organization
USA	United States of America
VAT	Value Added Tax

Abbreviations	Full form
VGF	Viability Gap Fund
VHF	Very High Frequency
WACC	Weighted Average Cost of Capital
WPR	Work Participation Rate
YEIDA	Yamuna Expressway Industrial Development Authority

1. Executive Summary

INTRODUCTION

- The Government of Uttar Pradesh has envisaged development of a green field airport at Jewar. Development of an airport is a one of the key enablers for the development of an industrial region (including urban centers) and is also expected to create a significant multiplier impact in the economy. International Civil Aviation Organization (ICAO) estimates the output and employment multipliers of aviation as 3.25 and 6.10 respectively. This implies that every 100 INR spent on air transport contributes to 325 INR worth of benefits, and every 100 direct jobs in air transport result in 610 jobs in the economy as a whole.
- In addition, the new airport would provide the National Capital Region (NCR) with a second facility after Indira Gandhi International Airport. This would support to decongest IGI Airport which is soon expected to reach its capacity.

PROJECT SITE AND FIELD SURVEY

- The proposed site of 1,334 hectare is located north of Jewar Village, in Gautam Buddh Nagar district of Uttar Pradesh (latitude 28° 09' N and longitude of 77° 35' E).
- **Topographical survey** revealed that the majority of the airport site land is cultivable. The terrain is almost flat with an elevation of 200 meters above mean sea level (AMSL), which is about 30meter above the bed level of the Yamuna River. The site is also away from the flood prone areas of Yamuna River. No hills or high grounds are visible in and around the site. There is no environmentally sensitive area within the site and nearby. No religious, archeological and historical place of importance exists with the airport and around.
- **OLS survey** highlighted three removable objects, an overhead water tank, a mobile tower and a brick kiln chimney protrude the surface.
- **Geo-technical survey:** The project area site is currently under agricultural use indicating that the soil is of alluvial nature. The soil ranges from sand to stiff clays including all combination of two extreme litho units. Locally these are called Bhur and Matiar. Invariably Kankars are associated with such type of soils. The modules of subgrade reaction of soil is in the range of 2-2.5 t/square meter and the CBR would range between 10 to 18%. Water table is reported to be 5 to 10 m below the ground level.

POTENTIAL OF PASSENGER TRAFFIC

- Passenger traffic at Indira Gandhi International airport (IGIA) has grown at a higher rate than the national average. In the last decade, air passenger traffic at IGIA has increased at a CAGR of around 14% compared to all India growth rate of 11.7%.
- Multi-variable linear and logarithmic regression models are used to predict the future hinterland demand. To determine the districts constituting IGI's hinterland, a detailed 24 hours survey for three days was undertaken at IGI airport. A random sample of over 6,700 passengers were collected. The survey revealed that almost 57 percent of the passengers using IGI Airport are from NCT of Delhi and districts of UP account for nearly 11-12 percent of the total passenger movement at IGI airport.
- Passengers' decision of using either IGI Airport or Jewar airport is expected to be dependent on four key factors- a) time taken to/from the airport; b) distance between the airport and the district; c) impact of new connectivity projects on the travel time & distance; d) availability of schedule airport services.
- In addition, capacity constraint at IGI Airport may also have a direct bearing on traffic at Jewar Airport. Upon completion of the fourth runway, IGIA may have a handling capacity of around 120 ATM per hour.
- As traffic at IGIA continues to grow, traffic from these peak hours would start to spill over to the proposed airport at Jewar. The spillover is expected to gain momentum by 2029-30.
- Given the demand pattern in the immediate hinterland of Jewar as well as capacity constraint at IGI Airport, in the year 2022-23, Airport at Jewar may serve a total annual passenger demand of around 5 million which may go up to 16 million by 2029-30, 71 million by 2043-44 and continue to operate at around 77million till end of the concession.

POTENTIAL OF CARGO TRAFFIC

- IGI airport handles around 30% of the total cargo handle in India. In the last 5 years, cargo traffic at the airport has increased at a CAGR of 14%. It is expected to reach 1 million mark in FY18.
- Export cargo accounts for nearly 35% of the international cargo at IGI airport. Electronics is one of the key commodities being exported from IGI airport followed by machinery parts, perishable etc. 65% of cargo movement is imports with electrical and machinery are the major import commodities handled at the airport.
- Around 75% of the cargo movement at IGI is from NCR Delhi. Gautam Budh Nagar and Ghaziabad account for almost 50% of the total hinterland movement.
- Multi-variable linear and logarithmic regression models are used to estimate the overall cargo demand in the hinterland. Out of the total demand, realizable demand at Jewar airport is estimated based on multiple factors: a) investment planned in the hinterland, particularly in industries that rely on air transport (like electronics, pharmaceutical etc.); b) distance between

the airport and the cargo generating centers; c) air connectivity at the airport and d) cargo holding capacity available on particular routes (dependent on air craft movement).

- Based on demand and supply side factors, overall cargo demand at the proposed airport is expected to be around 0.4 million metric tons in 2022-23 and reach up to 2.9 million metric tons by 2049-50.

Table 1: Cargo Projections for Jewar Airport

Year	Domestic cargo ('000 MT)	International cargo ('000 MT)
2022 - 2023	32	388
2027 - 2028	82	679
2032 - 2033	174	967
2037 - 2038	327	1,262
2042 - 2043	493	1,588
2047 - 2048	698	1,972
2048 - 2049	750	2,043
2049 - 2050	800	2,100

CONNECTIVITY

- Proposed site is well connected with NCR region and various other districts of western UP. The site is about 30 km from State Highway SH-22A i.e. the highway that connects Palwal and Aligarh and 700meters away from Yamuna Expressway. On the southern side, the airport is planned to be connected to the proposed Palwal Khurja expressway. In addition, there is 100 meter wide Eastern Peripheral Expressway, passing through Yamuna Expressway at Formula One Track, which connects the site to Palwal, Manesar, Ghazaibad, Bhagpat and Meerut.

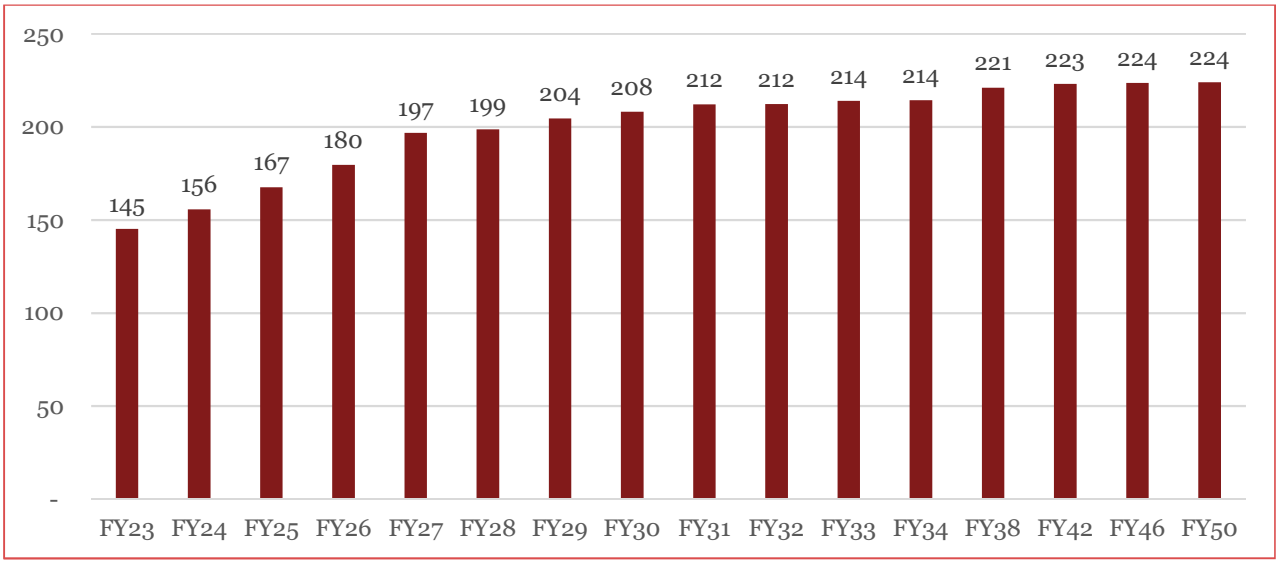
- It is recommended to leverage the exiting plan of developing Rapid Rail Transit Network which would connect NCR regions and Delhi. Government may explore connecting Sarai Kale Khan, which is a common terminus station for the existing planned routes of RRTS, to Shivaji Stadium and to Jewar. Alternatively, connectivity to Dhaulakuan to Sarai Kale Khan to Noida to Greater Noida to Jewar may also be explored.

- YEIDA has engaged DMRC to evaluate the connectivity options for the airport.

NON-AERONAUTICAL REVENUE POTENTIAL

- About 30%-40% of the total revenue at Indian PPP airport is contributed by non-aeronautical sources. On per passenger basis, PPP airport reports revenue of around 150-270 INR per passenger compared to 100-180 INR at AAI airports.
- Non-aeronautical potential of an airport is dependent on: a) profile of passengers using the airport (international/domestic; tourist/business) and b) nature of services provided at the airport.
- Given the nature of services and the passenger, the airport is expected to make a non-aeronautical revenue of around 145 INR per passenger (at FY18 prices) at the start of operations which is expected to stabilize to 200 INR (real prices at FY2018 levels) by FY28.

Figure 1: Non-aeronautical revenue per passenger (INR, Real terms)



MASTER PLANNING

- In the first stage of development, an area of 1,334 hectare has been earmarked for development of the airport.
- The proposed draft master plan for the airport is designed for the capacity of 70 million passengers per annum. The plan conforms to the Standards and Recommended Practices (SARPs) formulated by the International Civil Aviation Organization (ICAO) and promulgated by Directorate General of Civil Aviation (DGCA), India.
- It is recognized that the proposed airport at Jewar along with IGIA shall be a two airport system for NCR. As IGIA would start experiencing constraint at its peak hours, the spillover traffic from IGI would start building up peak hour requirement at Jewar airport. With time, as the constraints at IGI airport increases, there will be fewer hours with free slot availability. This would broaden the time window for slot allocation at Jewar and spread out the peak hour

demand at Jewar. The following table provides the peak hour requirement which forms basis of master planning.

Table 2: Peak hour handling requirement

Year	Domestic passenger handling at Jewar (million, annual)	International passenger handling at Jewar (million, annual)	Total passenger handling at Jewar (million, annual)	Peak aircraft movement (arrivals and departure) in an hour	Peak passenger handling in an hour	Peak domestic passenger handling in an hour	Peak international passenger handling in an hour
2022 to 2023	4.49	0.20	4.87	10	1058	1050	63
2025 to 2026	6.78	0.29	7.35	17	2249	2220	96
2028 to 2029	12.60	1.09	14.13	24	2981	2858	168
2031 to 2032	20.89	2.47	23.98	36	4230	3935	355
2034 to 2035	28.42	3.89	33.11	43	5685	5166	602
2037 to 2038	40.44	6.33	47.76	63	8195	7288	1055
2040 to 2041	49.45	8.21	58.85	74	9546	8419	1320
2043 to 2044	60.21	9.88	71.50	91	11356	10017	1578

- Given the traffic forecast, airport is suggested to be develop in 4 phases (as illustrated in table below).

Table 3: Development phases for Airport at Jewar

Development Period	Phase	Name	Operation Period	Design Year	Design Facility Capacity		
					Passengers	Cargo	ATM
FY20-FY22	Phase 1	Opening	FY23-FY27	FY28	12 MPPA	0.75MT	24
FY28-FY30	Phase 2	Short Term	FY31-FY32	FY34	30 MPPA	1.00MT	40
FY33-FY35	Phase 3	Medium Term	FY36-FY37	FY39	50 MPPA	1.5 MT	68
FY37-FY39	Phase 4	Long Term	FY40-FY50	FY44	70 MPPA	2.0 MT	85

- The implementation plan of the airport is different phases. The subsequent table provides the detailed items for each of the four phases.

Facilities (1st Phase)	
Sl. No.	**Details of items**
1	Runway 4150 x 60 for Code 'F'
	Code F, precision approach, Runway 10/28- Cat III, fully supported by Cat III ILS and approach lighting and visual aids.
2	Parallel End to End Taxiway
	Taxiway with two rapid exits conforming to Code F and Cat III requirements.
3	Apron for 4Code E/F and 21 Code C Aircraft with built in capacity to accommodate up to 5 Code E aircraft
4	Terminal Building for peak 2750 passenger capacity (Total Floor Area of 90,000 sq.m., Swing Gate operation)
5	Fire Station (Category 9)
6	Air Traffic Control Building
7	Isolation Bay
8	Operational Wall
9	Cargo Terminal Building (50,000 sq.m.)
10	Maintenance Building
11	Management Building
12	Security Staff Building
13	Energy Building
14	Property Boundary Wall
15	E & M Facilities
a	Power House
b	Electrical Substation
c	Distribution Substation
d	AGL and Visual Aids to support Cat III operations
e	METFARM

Facilities (2nd Phase)	
Sl. No.	**Details of Items**
1	Runway 3900 x 60 for Code 'F'
a	Code F, precision approach with Cat- III approaches, fully supported by Cat III approach lighting and visual aids for Rwy28R and Cat I for Rwy10 L
2	Parallel End to End Taxiway for the 2nd Runway

Facilities (2nd Phase)	
Sl. No.	**Details of Items**
a	Taxiway System conforming to Code F and Cat III requirements.
3	Apron expansion for 27 additional bays (2Code E and 25 Code C) with flexibility to accommodate 5Code E aircraft.
4	Terminal Building for peak of additional 2750 passenger. Capacity (Total Floor Area of 90,000 square meters, Swing Gate Operation)
5	Up-gradation of Fire Station to Category 10 and two substations for the second runway.
6	Expansion of Cargo Terminal Building (20,000 sq.m.)
7	E & M Facilities
a	Distribution Substation
b	AGL and Visual Aids to support Cat III operations (2nd Runway/ Taxiways)
c	METFARM (2nd Runway)
8	Augmentation of all the utilities to match the enhanced infrastructure.

Facilities (3rd Phase)	
Sl. No.	**Details of Items**
1	End to End 2nd Parallel Taxiways conforming to Code F Cat- III operation
2	Apron expansion for 25 additional bays (2 Code F, 4 Code E and 27 Code C)
3	Terminal Building expansion for peak of additional 3500 Pax. Capacity (Total Floor Area of 1,60,000 square meters)
4	Expansion of Cargo Terminal Building (30,000 sq.m.)
5.	Three Rapid exit taxi tracks for each of the runway 10R/28L
5	E & M Facilities
a	Distribution Substation

Facilities (4th Phase)	
Sl. No.	**Details of Items**
1	End to End 2nd Parallel Taxiway conforming to Code F Cat- III operation
2	Apron expansion for 25 additional bays (24 Code F, 10 Code E and 246 Code C)

Facilities (4th Phase)	
Sl. No.	**Details of Items**
3	Terminal Building expansion for peak of additional 3000 Pax. Capacity (Total Floor Area of 1,60,000 square meters)
4	Expansion of Cargo Terminal Building (50,000 sq.m.)
5	Three Rapid exit taxi tracks for each of the runway 10L/28R
5	E & M Facilities
a	Distribution Substation

CAPITAL EXPENDITURE

- Based on the master plan, the capital expenditure of the project is estimated to be around 15,754 crore INR (real FY18 prices). These are divided into 4 construction phases: Phase 1 cost of around 3745 crore INR, Phase 2: 3537 crore INR, Phase 3: 4,079 crore INR and Phase 4: 4,384 crore INR.

FINANCIAL ASSESSMENT

- Keeping in perspective the demand findings along with the overall product mix, financial assessment has been undertaken for the subject land parcel. Further, post the demand assessment of identified economic uses, a detailed financial assessment was undertaken to arrive at the financial viability of the project.
- The financial assessment assumes the following key dates:
    - Financial Closure – 31 March 2019
    - Construction start at the airport – 1 April 2019
    - First phase of land acquired by the government by March 2019
    - Commercial operations date – 1 April 2023
- Each phase of construction is expected to be for 36 months (refer capital expenditure chapter and capex profiling section).
- Based on the current economic regulation governing the airport sector, yield requirement for the first control period would be approximately 800 INR per passenger and UDF of under 500 INR per passenger.
- Cost of equity and cost of debt is assumed to be 16% and 10.5% respectively.
- Based on the assumptions, the financial analysis of aero and non-aero components of the project indicates an Equity IRR of 16.3% and Project IRR of 14.4% for the project SPV.

2. Introduction

2.1. General

The Government of Uttar Pradesh has envisaged development of a green field airport at Jewar. Development of the airport is expected to connect cities such as Agra, Mathura, Gautam Buddh Nagar etc. to the world's aviation network. This will ensure improved industrialization in the region as it would integrate the industries in the hinterland to the global value chains. Improvement in air connectivity may also provide boost to the tourism sector by increasing traffic inflow at the existing tourist sites and create more avenues for the development of new tourist centers. The proposed airport will also help in decongestion of IGI Airport in Delhi, which is soon expected to reach its capacity.

The airport development project was first conceptualized in 2004 and a techno-economic feasibility report (TEFR) was prepared by L&T Ramboll Consulting Engineers which was subsequently revised in 2008. Now the mandate for the development of the green field airport at Jewar has been given to Yamuna Expressway Industrial Development Authority (YEIDA). YEIDA has appointed a consortium led by PricewaterhouseCoopers Private Limited for revision of the TEFR.

2.2. Scope of the study

The scope of services for the preparation of the techno economic feasibility report include following areas:

- **Location Assessment**: The study evaluates attractiveness of the identified site at Jewar to understand its suitability for various projects and asset classes. Further the study identifies major primary and secondary regions around the proposed site that would impact the demand of the proposed development.
- **Demand Assessment:** The study also includes a detailed market assessment to estimate the potential air traffic demand at the airport. This would include identification of the project catchment area with respect to international and domestic operations for both passenger and cargo. In addition to volume estimation, the study also includes profiling of the expected demand and its growth trajectory.
- **Environment and Social Impact Assessment**: As part of the study an environment and social impact assessment of the project involving community interactions was carried out. The study also assessed the social impact arising out of the proposed project implementation and suggested mitigation measure for such adversities. Additionally, a detailed environmental study was also undertaken to help in obtain environmental clearances required for the project from

designated authority including documents to be prepared for the purpose as per the requirement of the authority concerned.

- **Master Planning** :
  - **Detailed study and mapping of the region**: Detailed analysis of the region of the following sectors through primary site visits and secondary data from concerned local officials, transport department etc.
  - **Infrastructure demand and supply gap assessment**: Assess the future demand and existing status of infrastructure services. Prepare plan for the development of physical and social infrastructure in a phased manner.
  - **Land use plan and development control regulations**: Preparation of detailed land use plan indicating the various activities and circulation pattern.
- **Financial evaluation of the project:** Estimate cost for development, operation and maintenance components involved in the proposed airport. Also including phasing of the project to ensure optimizing the investment requirement of the project.

  In addition, provide revenue estimate for the proposed airport including revenue from aeronautical activities as well as non-aeronautical sources. Further evaluate the cash flow expected from the project along with the expected financial returns including project IRR, equity IRR, DSCR, cash flows, etc.
- **Project structuring options and bid process management:** Evaluate the most suitable project structuring option for development of the project i.e. SPV, PPP, JV etc.

2.3. Project site

Spread over an area of 1,334 hectares (Ha), the proposed site for the airport is located at latitude 28° 09' N and longitude of 77° 35' E, north of Jewar Village, in Gautam Buddh Nagar district of Uttar Pradesh (see Figure 2). The Yamuna Expressway is located at about 700 meters from the project site. The site is about 70km from IGI Airport. The site location has been presented in Figure 3.

Figure 2: Location of the proposed airport

Jewar, the site chosen or establishing the second international airport for NCR is strategically located at about 72Km from IGI Airport, 40Km from Noida and Multi-modal logistic hub (Dadri). City of Aligarh is on south west of the site just at 45Km from the site. Located close to Yamuna Expressway, the world famous tourist center Agra is just 130kms from the airport.

Initially, the site measuring approximately 6,500 meters from east to west and 4,750 meters from north to south, an area of approximately 3,000 Ha was delineated for establishing the airport. Considering the constraints, it is intended to develop the airport in two stages. In the first stage it is envisaged to develop the airport over an area of approximately 1334hectare, which is now under acquisition. Figure 4 delineates the area now under acquisition and earmarked for airport development in the first stage.

Figure 3: Proposed site for Jewar Airport

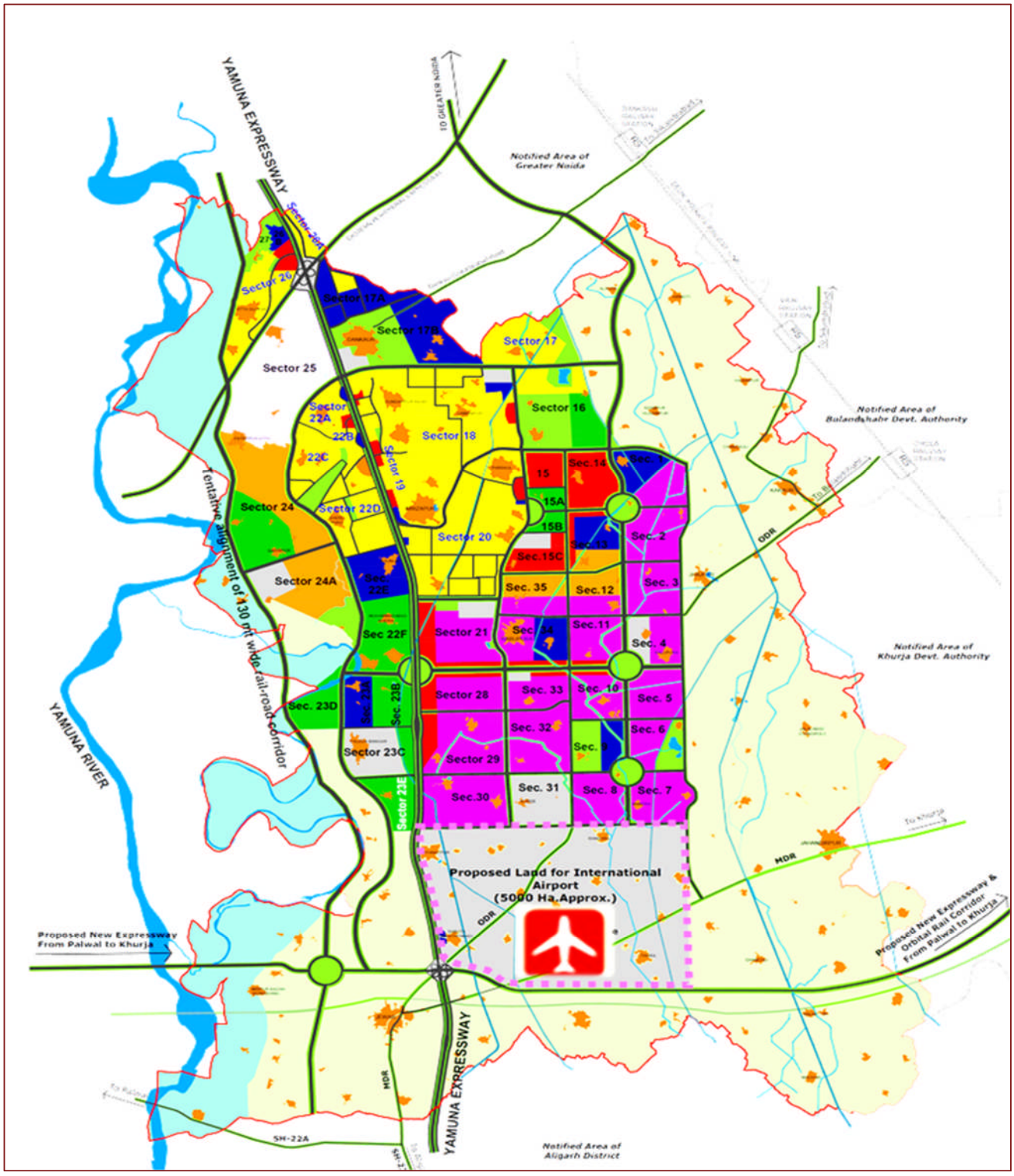
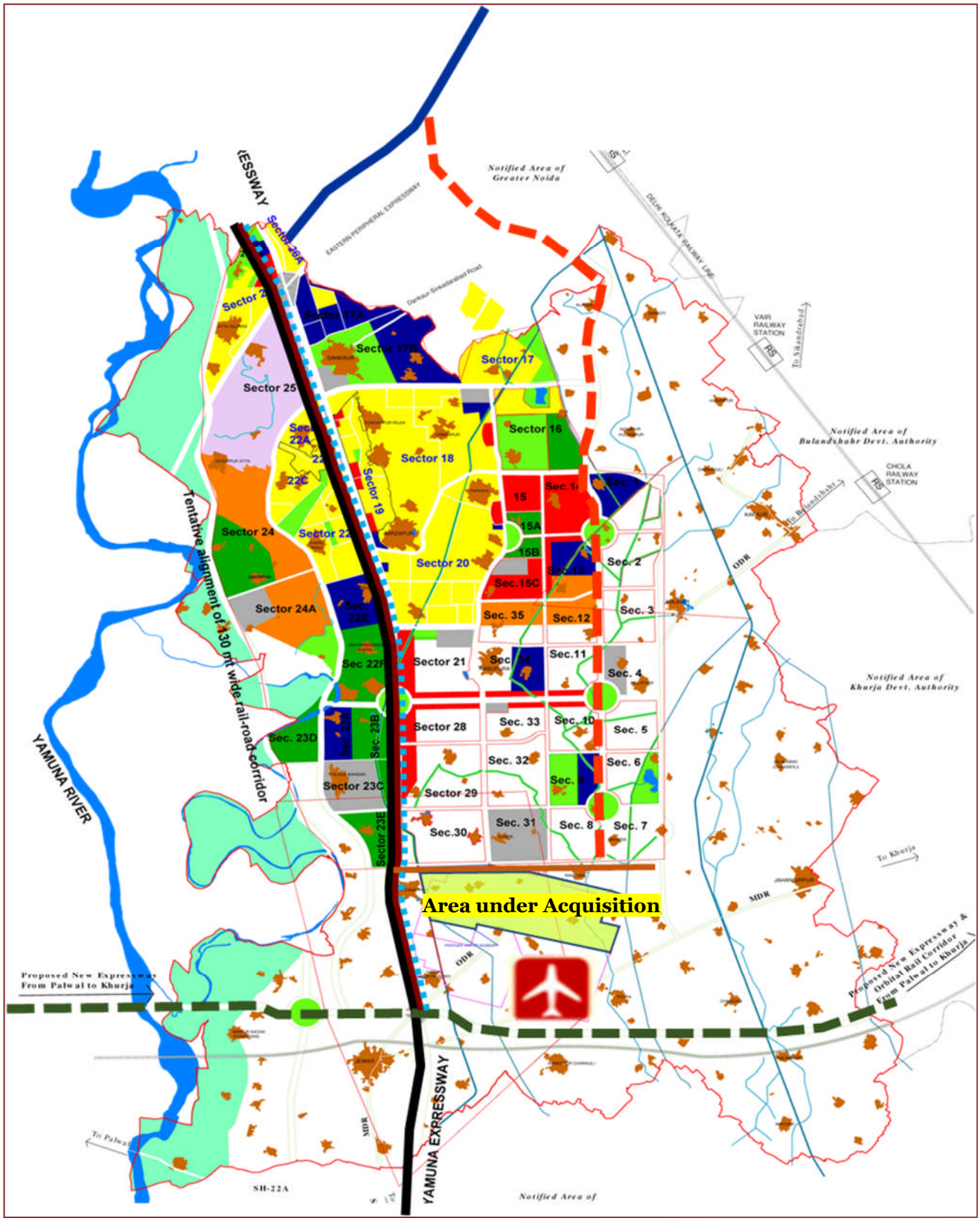


Figure 4: Land acquisition for Jewar Airport



2.4. Topography and site condition

Majority of the airport site land is cultivable and is in agriculture use. The terrain is almost flat with an elevation of 200 meters above mean sea level (AMSL), which is about 30 meters above the bed level of the Yamuna River. The site is also away from the flood prone areas of Yamuna River. No hills or high grounds are visible in and around the site. There is no environmentally sensitive area within the site and nearby. No religious, archeological and historical place of importance exists with the airport and around. Water Table is reported to be 5 to 10 meters below the ground level.

Examination of site on Google earth (Figure 5) as well as the topographic survey reveals that the terrain is fairly flat. A typical longitudinal and transverse profile of the terrain is placed at Figure 6 and Figure 7.The longitudinal profile shows that the land slopes downwards towards east and the variation is within 7 meters over a stretch of 6 km. Transverse profile too shows that variation in ground level is less than 3 meters over a stretch of 2.2 km.

Figure 5: Airport site on Google Earth

Figure 6: Longitudinal Profile of Airport site

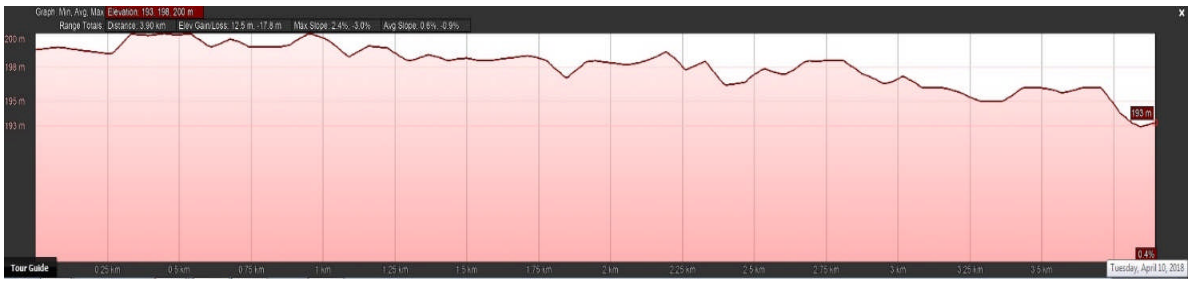
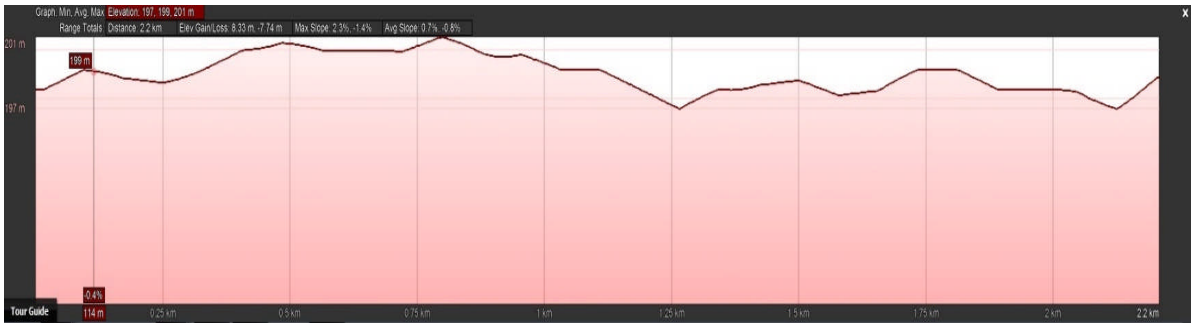
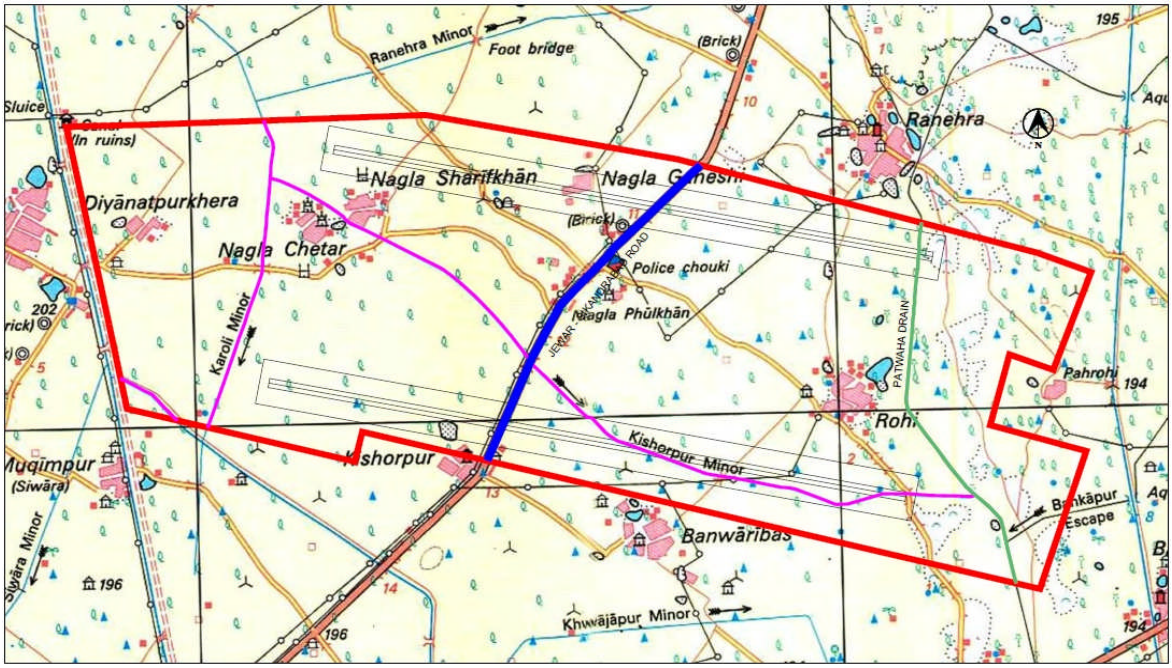


Figure 7: Transverse Profile of Airport site



The proposed airport project area, duly marked on the Survey of India Toposheet Number is depicted in the Figure 8. A larger picture of the same is also placed at Appendix. As stated above the airport land is predominately agriculture with network of canals and settlements. The major settlement within the site are Rohi, Kheda Nagla Sharifkhan, Nagla Cheter and parts of Kishorpur. The Jewar -Sikandrabad road cuts across the airport area and the same is required to be suitably diverted. All the roads falling within the project site, except the roads which connects the villages within the site require diversion for airport development.

Figure 8: Airport site on topo-sheet

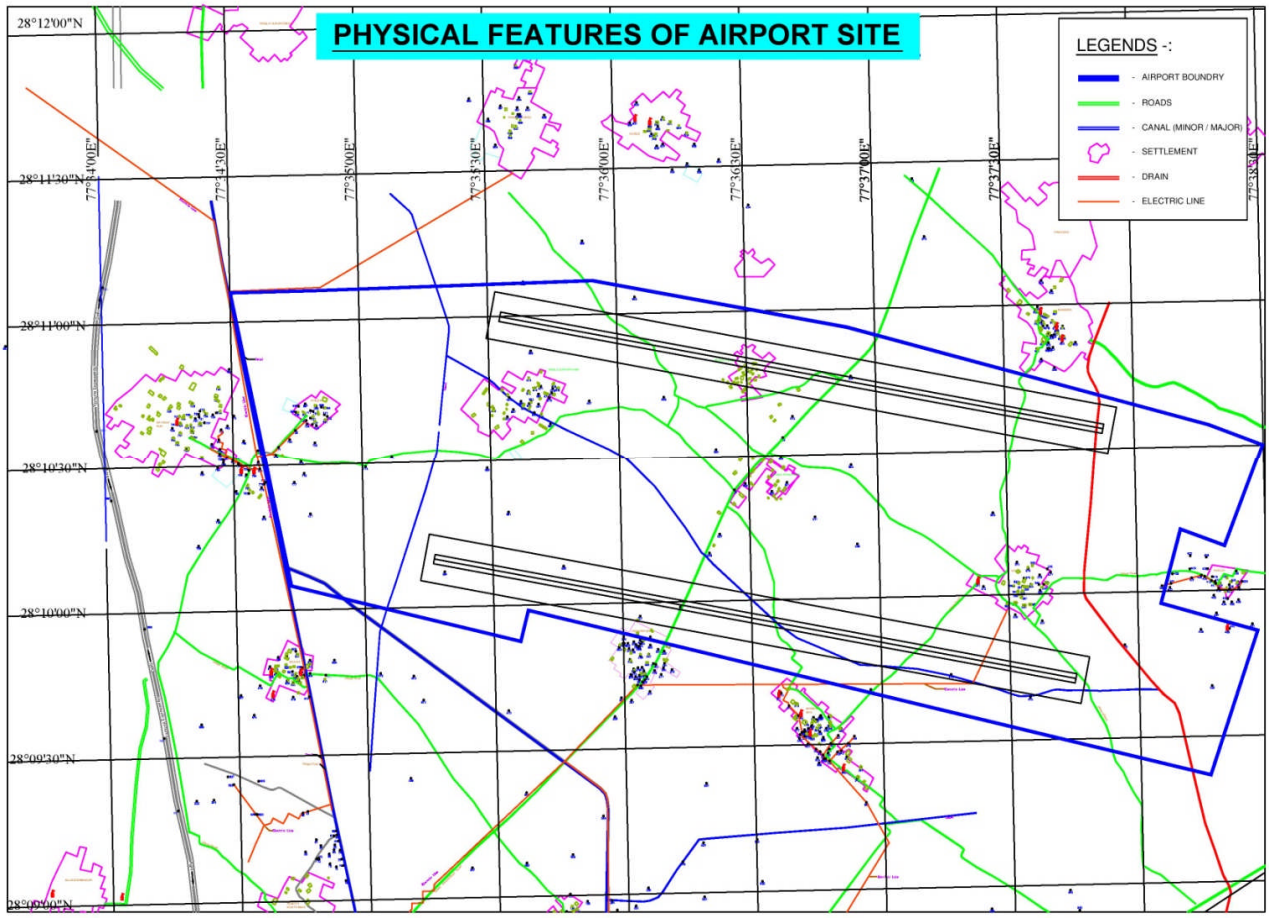


Pathwaya Nala, running north-south at east end needs diversion for the development of airport. One major distributaries; Bajauta, on the western side close to the south-west corner of the land would require diversion at this stage of the project. A minor canal, known as Karoli minor, shall be buried.

However, it may continue to feed Ranhera minor outside the airport boundary. A map showing physical features of the site is placed at Figure 9.

Relocation of the entire existing villages from the site is essential and critical for development of Jewar Airport. YEIDA is currently in discussion with the villagers regarding schedule of their shifting from the site area, and their relocation shall be effected soon. The site is expected to be available for airport development by end of the current calendar year.

Figure 9: Physical Features of Airport



2.5. Existing connectivity infrastructure

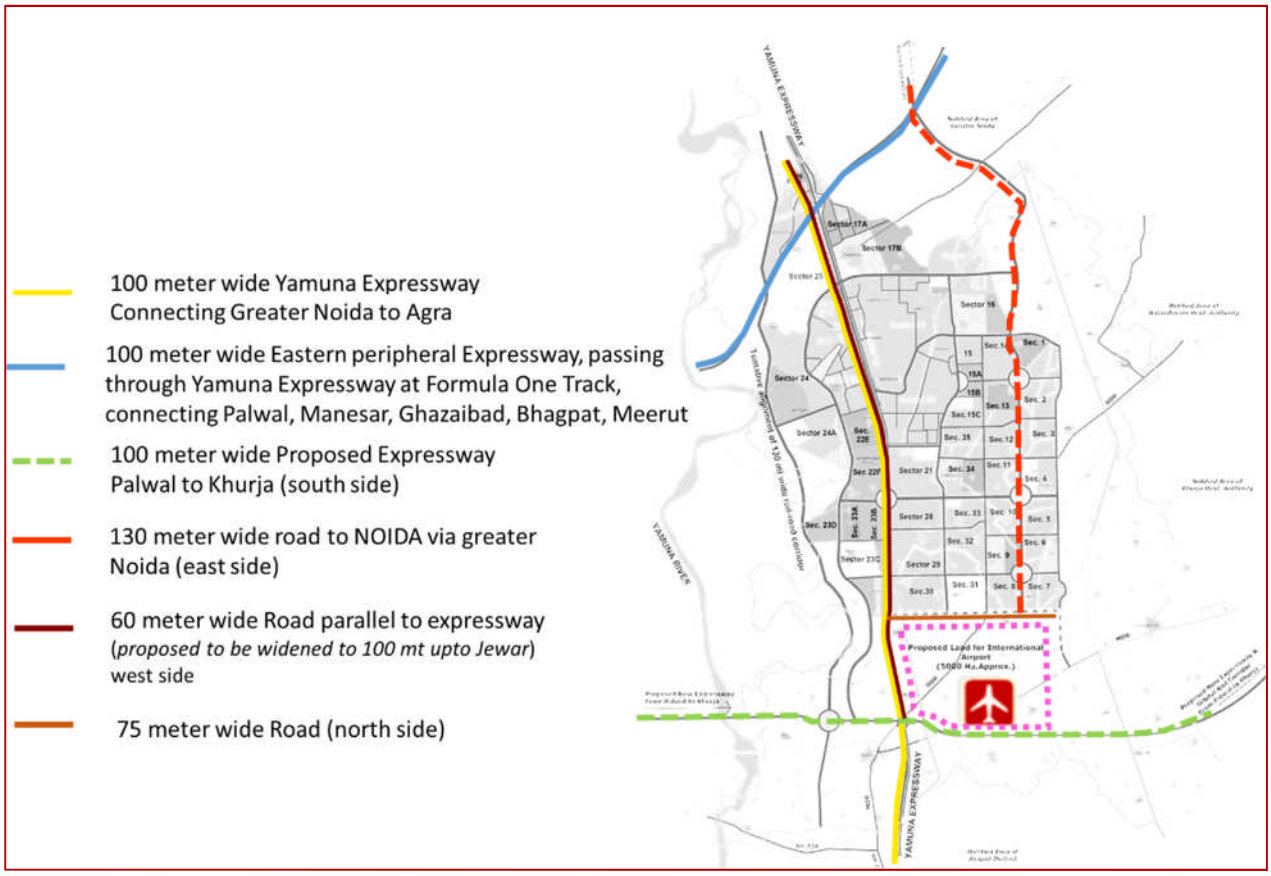
The project region is well connected with NCR as well as various other districts in western UP.

- Site is about 30 km from State Highway SH-22A i.e. the highway that connects Palwal and Aligarh.
- There is 100 meter wide Eastern Peripheral Expressway, passing through Yamuna Expressway at Formula One Track, which connects the site to Palwal, Manesar, Ghazaibad, Bhagpat and Meerut.

- On the southern side, the airport is planned to be connected to the proposed Palwal Khurja expressway.
- Site is connected to Noida via Greater Noida by a 130 meter wide road.

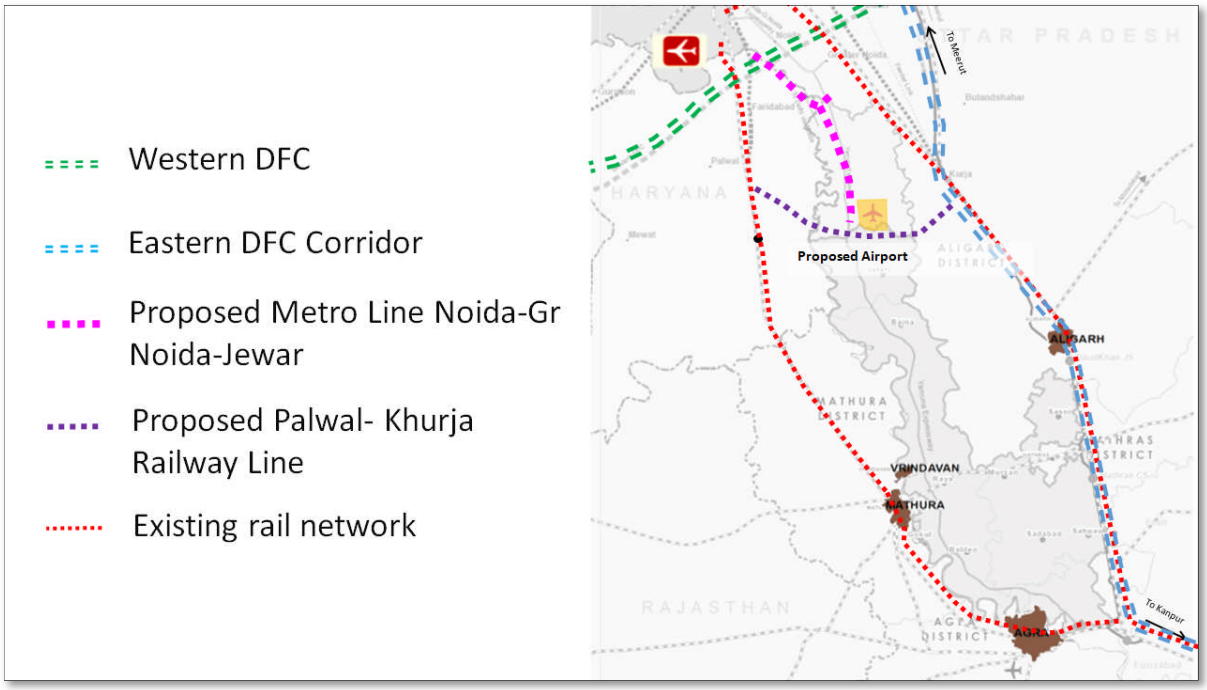
The Figure 10 depicts the network of roads connecting the proposed site to different districts around the airport.

Figure 10: Proposed transport network around Jewar Airport site



The site also has a well laid railway network. YEIDA has also taken an initiative and liaison with DMRC to extend its feasibility study of the metro connectivity. DMRC is currently conducting feasibility study to connect Pari Chowk (on Noida-Greater Noida Line) to Sec 20 in YEIDA area. Another option of extending Airport Express line from New Delhi to Pari Chowk is also under investigation. Subsequent sections provide commercial and financial details of the proposed project.

Figure 11: Railway connectivity to the proposed site

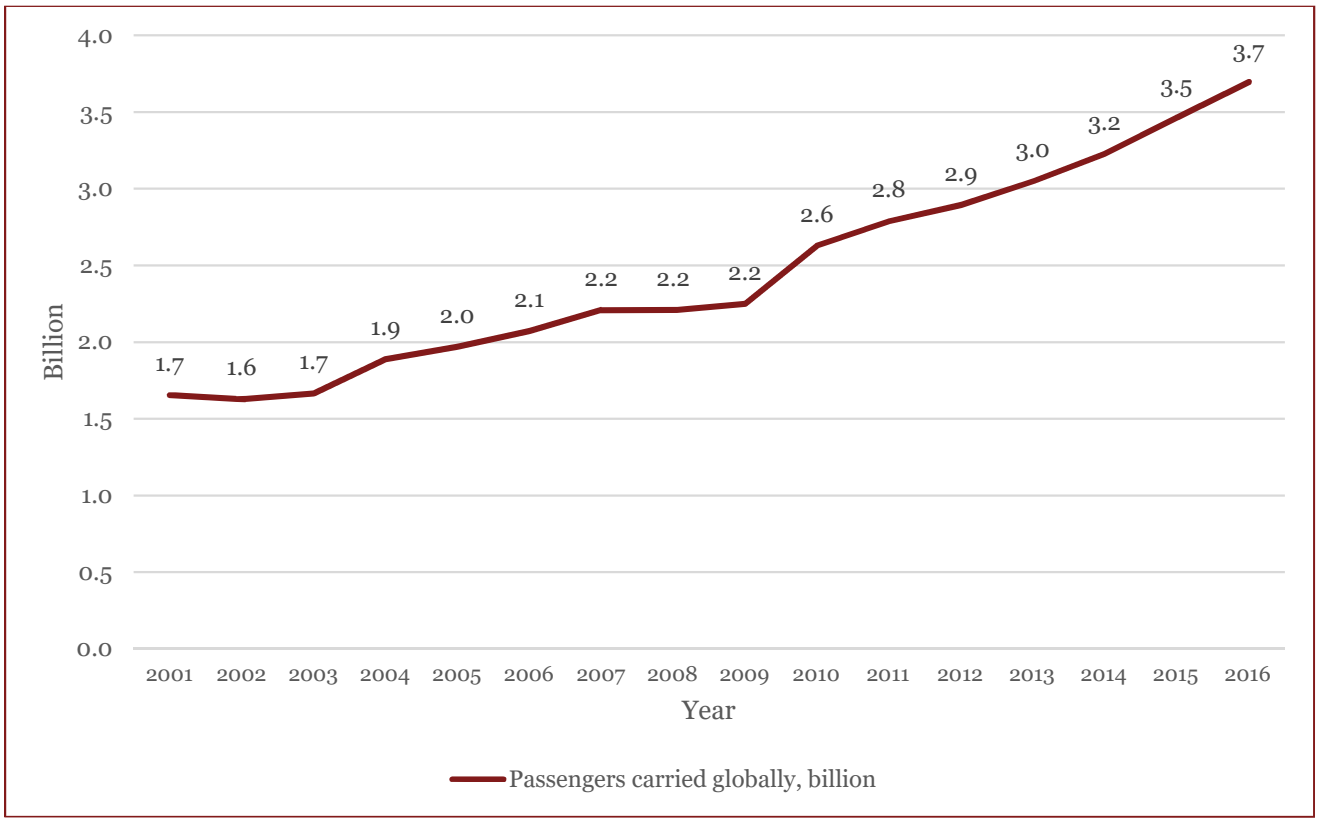


3. Trends in aviation sector

3.1. Global aviation sector trends

The aviation sector across the world has shown steady growth in the past decade and the half, despite occasional stagnation of demand during periods of global economic recession like in 2008 (Figure 12). Between 2001 and 2016, global growth in air transport (in terms of passengers carried) has been at a CAGR of 5.3 percent.

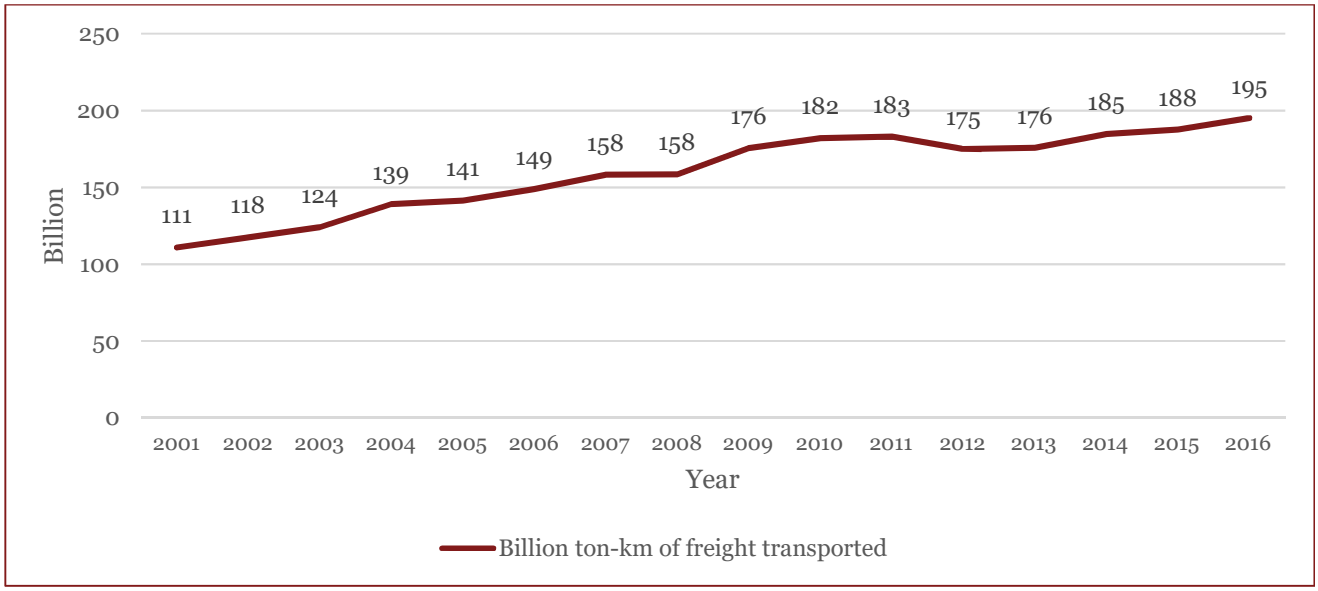
Figure 12: Passengers carried via air transport globally, in billion



Source: World Bank

In terms of air cargo movement (ton-km transported), although the overall movement has increased by 1.75 times in the last decade and a half (a CAGR of 3.8 percent between 2001 and 2016), the fluctuation in the demand pattern has been observed to be more volatile than that for passengers.

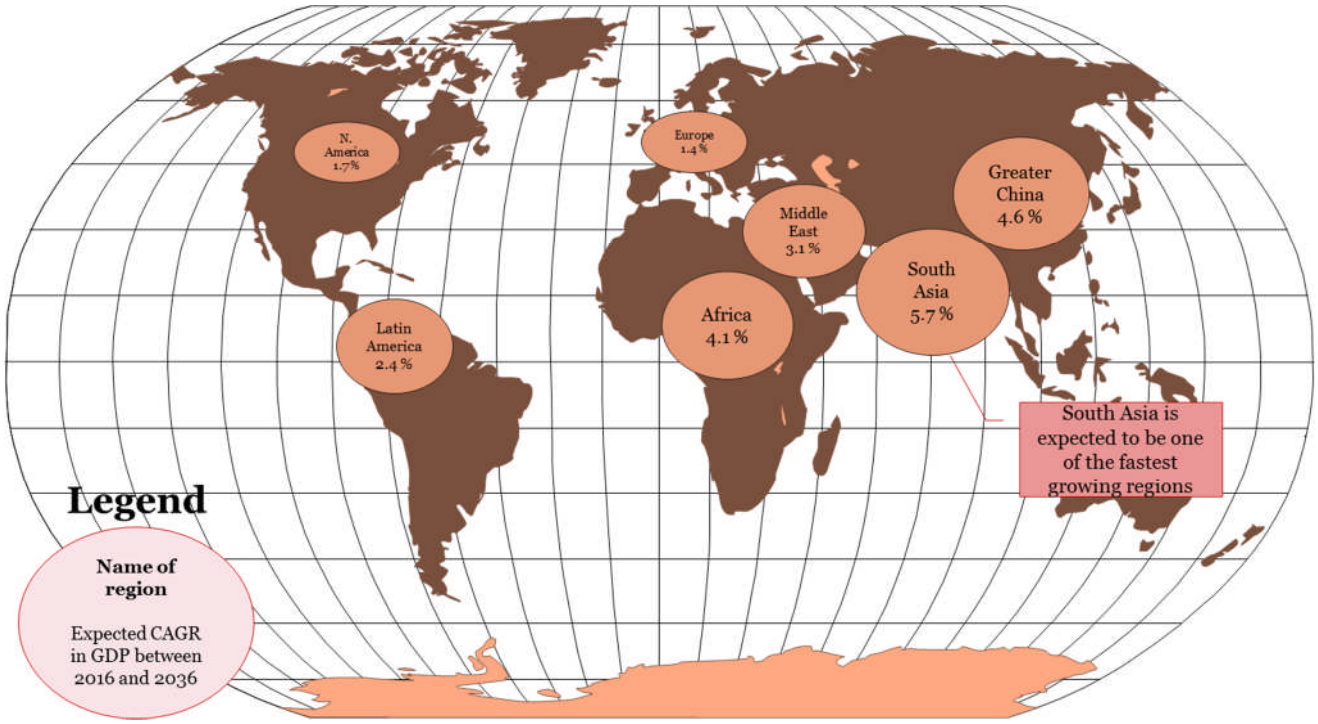
Figure 13: Freight transported by air globally, billion ton-km



Source: World Bank

The growth in air traffic in a region tends to be strongly correlated to its GDP. Economically, the South Asian region is expected to be one the fastest growing regions (Figure 14), and consequently become one of the fastest growing markets for the aviation sector in the years to come.

Figure 14: World GDP growth projections (CAGR for 2016- 2036), by region

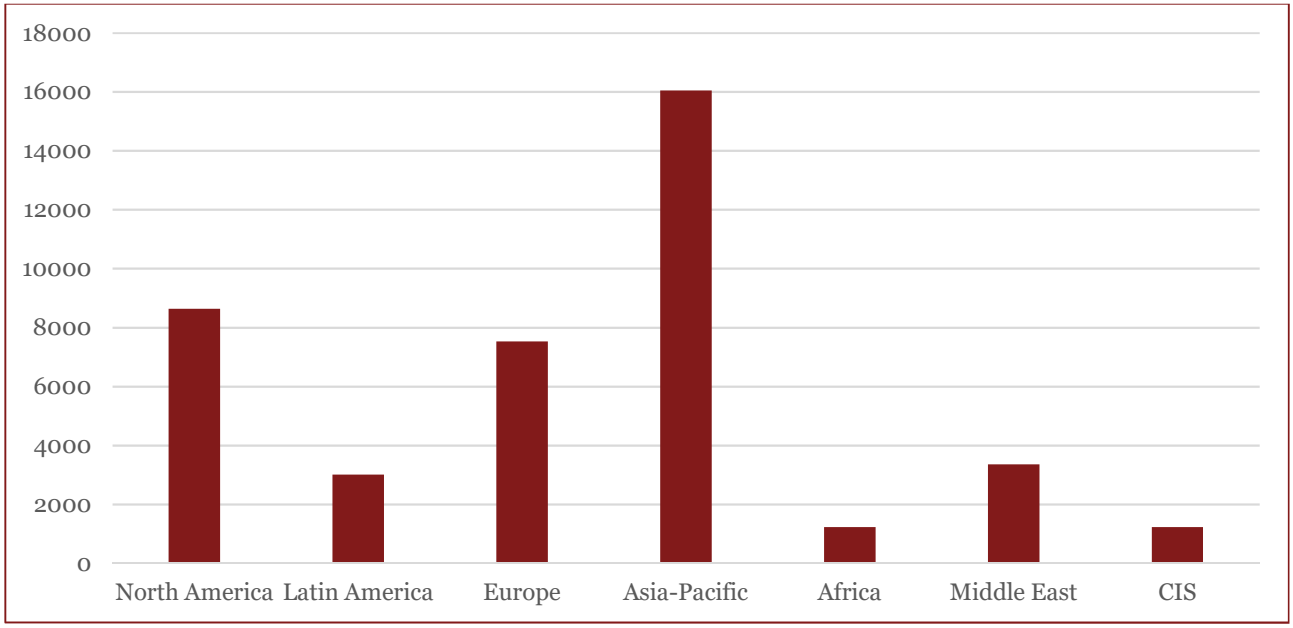


Note: Regions depicted in the figure are not exhaustive

Source: Market Forecast 2017-2036, Bombardier Commercial Aircraft

The same sentiment is also reflected by aircraft OEMs and other international agencies. As per Boeing, the air fleet demand in Asia Pacific region is expected to be nearly 1.5 times higher than North America. Similarly, as per IATA, in the next three decades the annual air passenger growth rate in Asia Pacific region would be around 4.6% compared to about 2.3% in North America and 2.3% in Europe.

Figure 15: Number of expected deliveries by Boeing (2017- 2036), by region



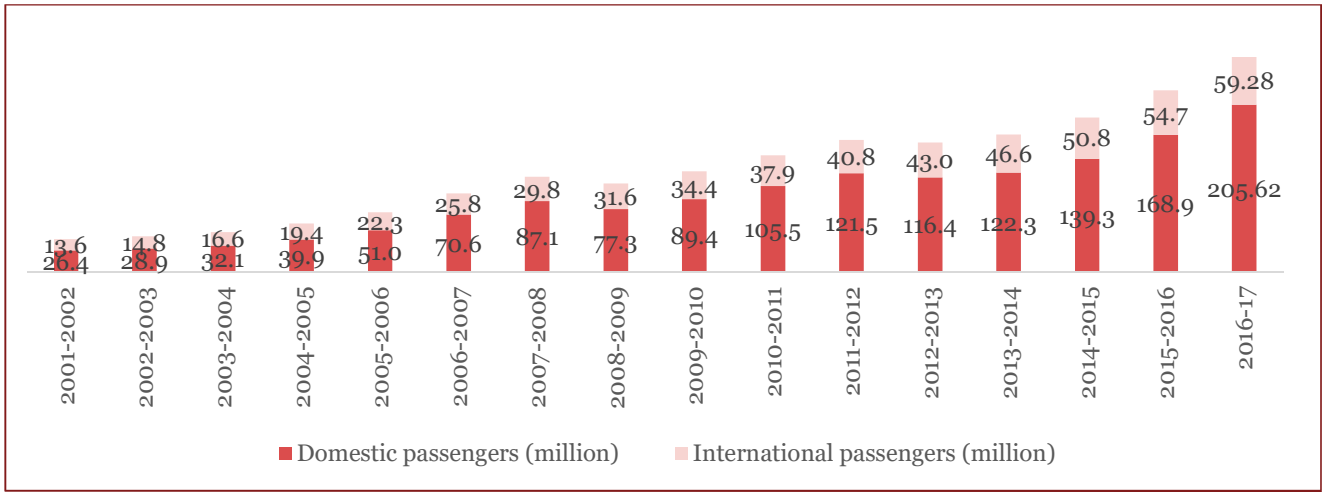
Source: Current Market Outlook 2017-2036, Boeing

India is expected to play a leading role in driving the growth in Asian aviation market. It is projected to become the third largest air passenger market by 2036.

3.2. Aviation trends in India

The total passengers handled at airports in India has increased from 143.4 million in 2010-11 to 264.9 million in 2016-17, a CAGR of ~10 percent (Figure 16). This growth is led by the growth in domestic traffic movement. During the period from 2011-12 to 2016-17 domestic traffic witnessed a CAGR of 11 percent while international traffic witnessed a CAGR of 7.7 percent.

Figure 16: Air traffic in India, million passengers handled

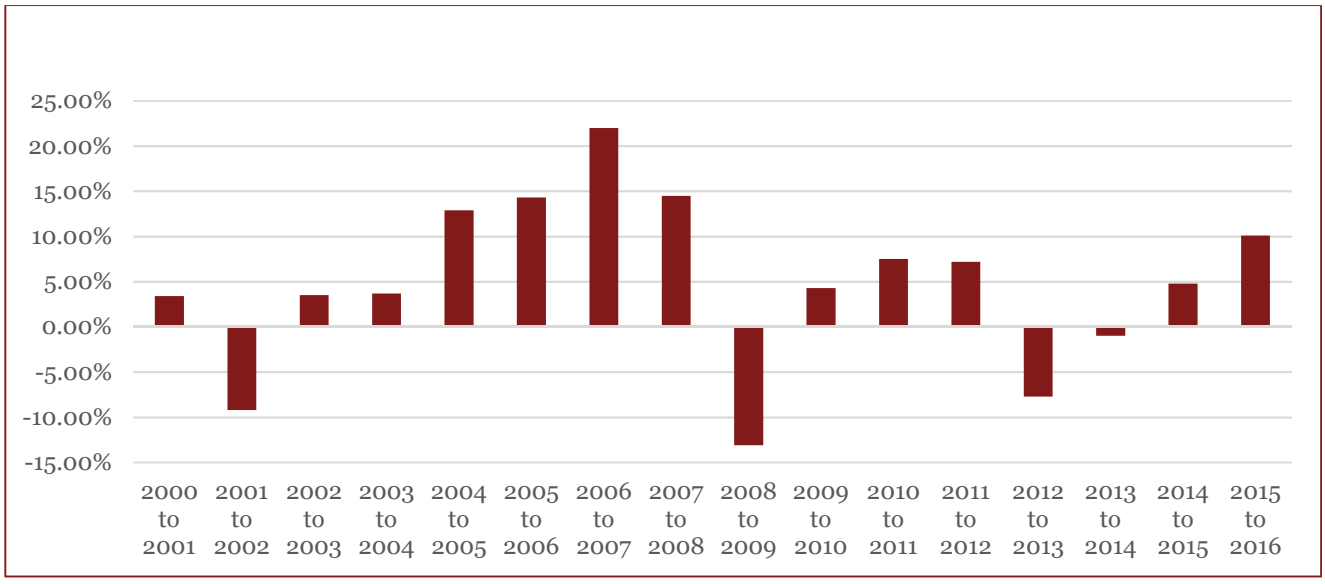


Source: DGCA

In recent years the growth rate of air traffic is India has been faster than the growth of GDP of the country. During 2000-01 to 2015-16, the growth rate of air traffic has largely exceeded the growth rate of GDP (see Figure 17).

For the future, the Government of India has set ambitious targets. For example, in the National Civil Aviation Policy 2016, one of the targets is to achieve an annual domestic ticketing of 300 million by 2022 and 500 million by 2027 compared to ~ 70 million during 2014-15.

Figure 17: Difference in percentage growth rates of passenger air traffic and GDP, for India

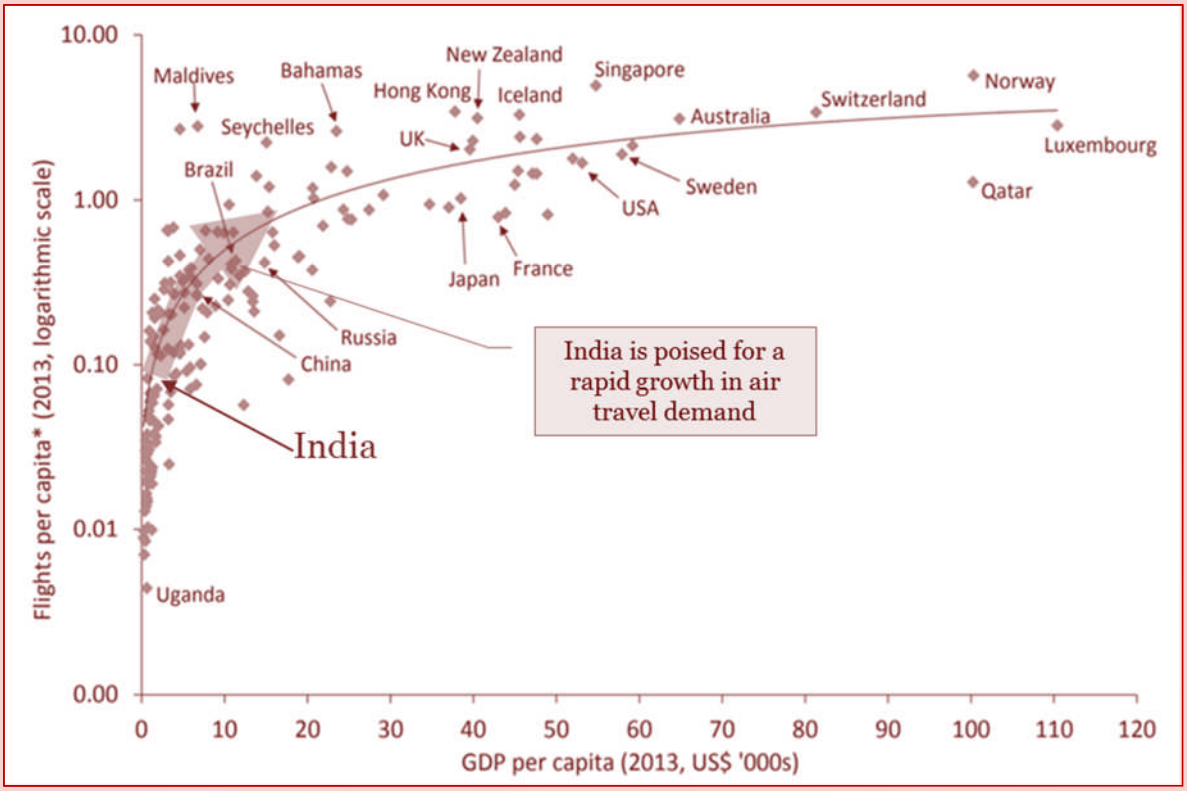


Note: The growth rate of GDP in this analysis is based on World Bank estimates at 2010 constant US Dollars. For the purpose of comparison of GDP growth rate and air traffic growth rate, two year moving averages for GDP estimates is used to bring them to financial year terms; for a particular year if GDP growth is x % and air traffic growth is y %, difference in percentage growth rates of air traffic and GDP = (y – x) %

Source: DGCA, World Bank, PwC analysis

Despite the large size of the aviation market in India, the per capita air trips in India is lower (at around 0.1 trips annually, 2015-16)[1] than the potential. The curve in the Box 1 depicts the correlation curve between per capita income and flights per capita. Even at its current per capita income level, air travel in India is lower than typically observed. This highlights scope for further increase in air travel in the country.

Box 1: IATA correlation between per capita income and trips per capita

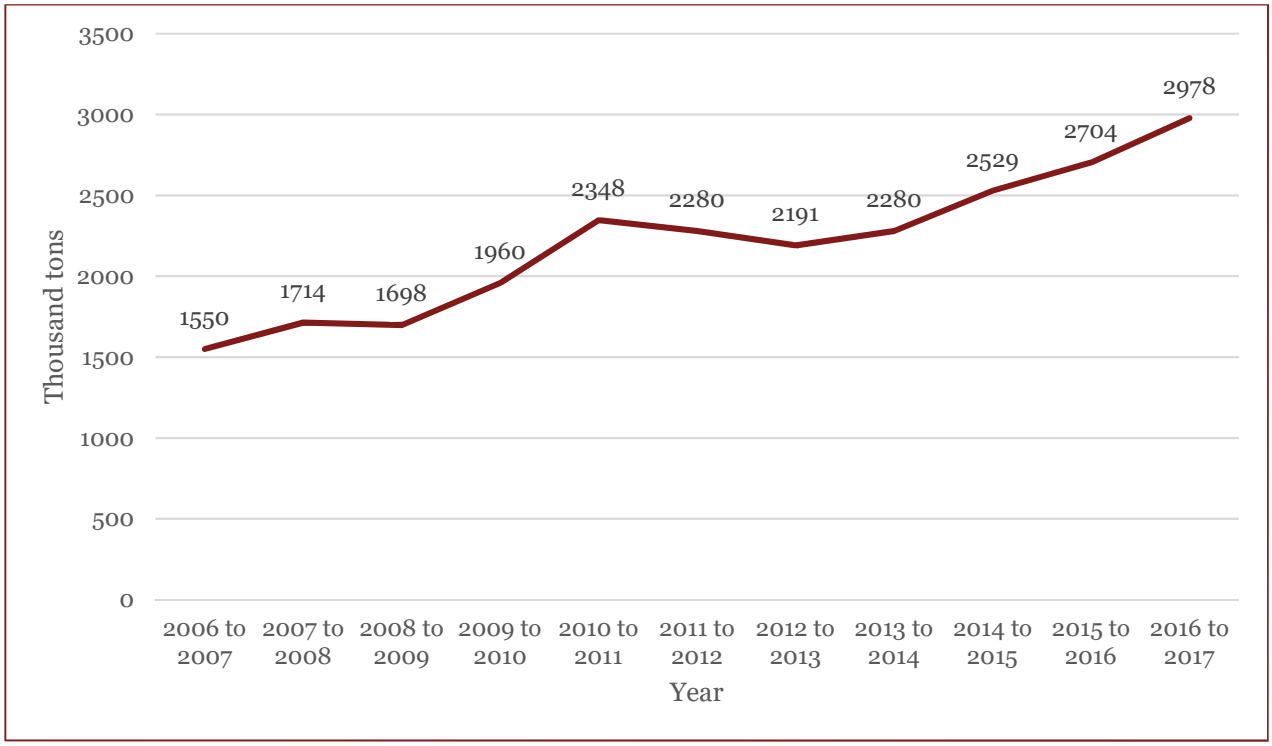


Note: The graph used is an extract from IATA's publication titled "The shape of air travel markets over the next 20 years." Retrieved on 7th March 2018 at 12.50 hours IST from https://www.iata.org/whatwedo/Documents/economics/20yearsForecast-GAD2014-Athens-Nov2014-BP.pdf

The air cargo movement in India is also growing. In the last decade (2006-07 to 2016-17), air cargo handling in India has grown at a CAGR of 6.7 percent. Figure 18 depicts trends in air cargo handling in India.

[1] Number of total passenger departures divided by population

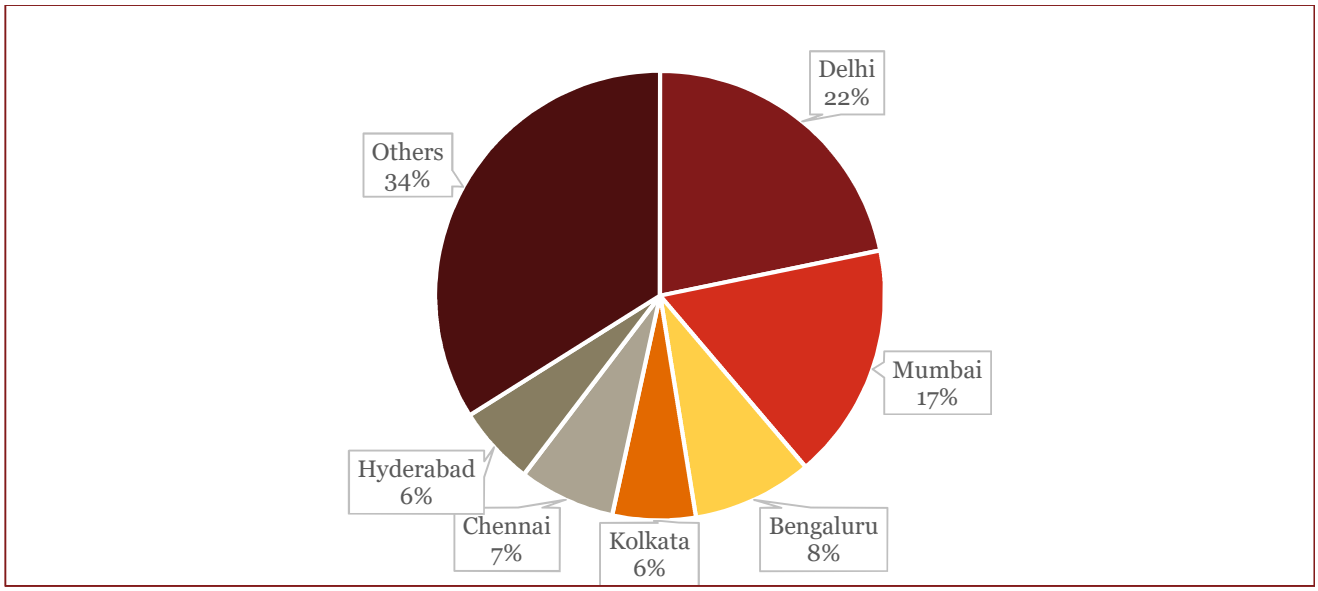
Figure 18: Total cargo handling at airports in India, thousand tons annually



Source: DGCA

The high growth registered by India has largely been driven by growth in the Tier I cities. For instance, out of the total cargo handling in India, almost over 50% of the handling is undertaken at IGI Airport, Delhi and Chhatrapati Shivaji International Airport, Mumbai. Similarly, approximately 66 percent of the total passenger handled in India are at Tier I airports like Delhi, Mumbai, Hyderabad, Bangalore, Chennai, and Kolkata.

Figure 19: Passenger handling at Indian airports, share by city (2016-17, annual)



Source: DGCA

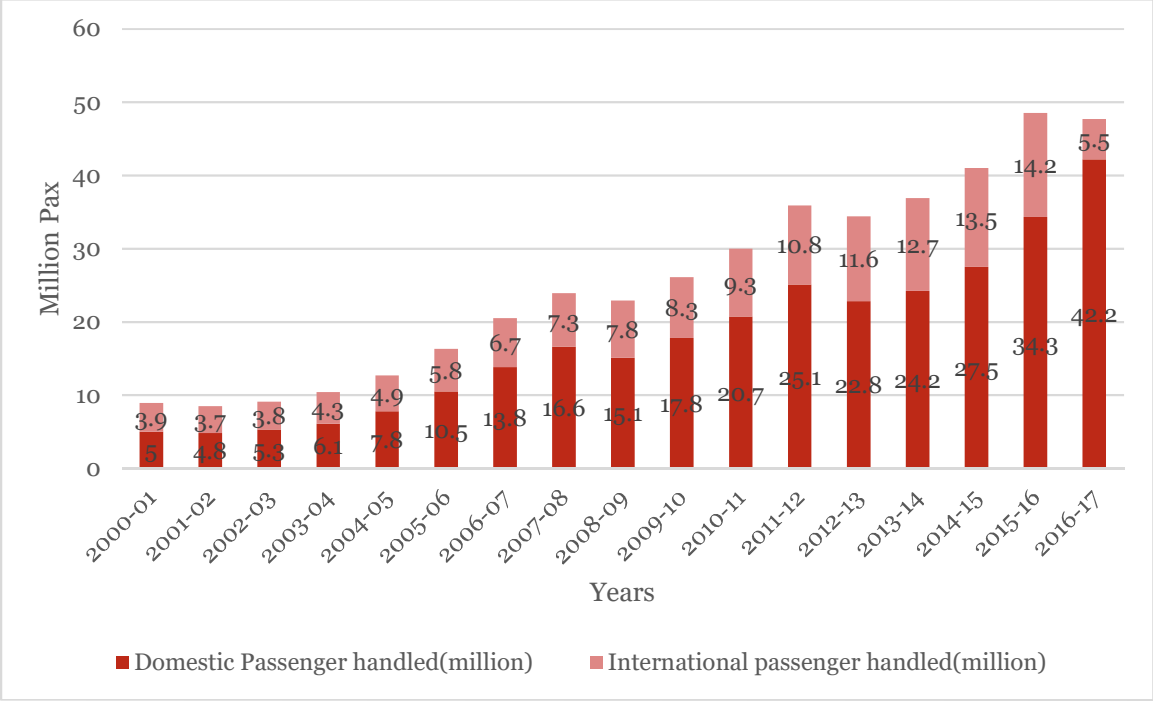
With growth in traffic, airport operators are consistently enhancing the passenger handling capacity of the airports. For instance, by 2034, IGI airport is expected to increase its design capacity from approximately 62 million to about 109 million. Similarly, Kempegowda International Airport, Bangalore has planned to ramp up the capacity from the current capacity of about 20 million passengers to 40 million in 2021. In spite of increase in capacity, rising passenger volumes is pushing planners to look at the option of building a second airport in some of the cities. For instance, in FY17, City and Industrial Development Corporation (CIDCO) appointed a private developer for the development of a second airport in Mumbai which would operate alongside with the existing Chhatrapati Shivaji International Airport. Similar requirement is also envisaged in the Delhi NCR region.

The next section discusses the traffic trend in Delhi NCR and the expected capacity constraints at IGI airport that may justify the requirement of a second airport.

3.2.1. Aviation trends in Delhi NCR

In the recent years, air traffic in the Delhi NCR, currently catered solely by IGIA, has grown at a higher rate than the national average. During 2011-12 to 2016-17, IGI Airport traffic has grown from an annual passenger of 35.9 million to 57.7 million– a CAGR of ~ 10 percent in the five year period. As has been the case with overall air traffic growth in India, the growth in air traffic at IGI Airport has also been domestic demand led. During the period from 2011-12 to 2016-17 domestic traffic witnessed a CAGR of ~11 percent while international traffic witnessed a CAGR of ~7.5 percent (Table 4).

Figure 20: Air traffic at IGI Airport, million passengers handled annually



Source: AAI

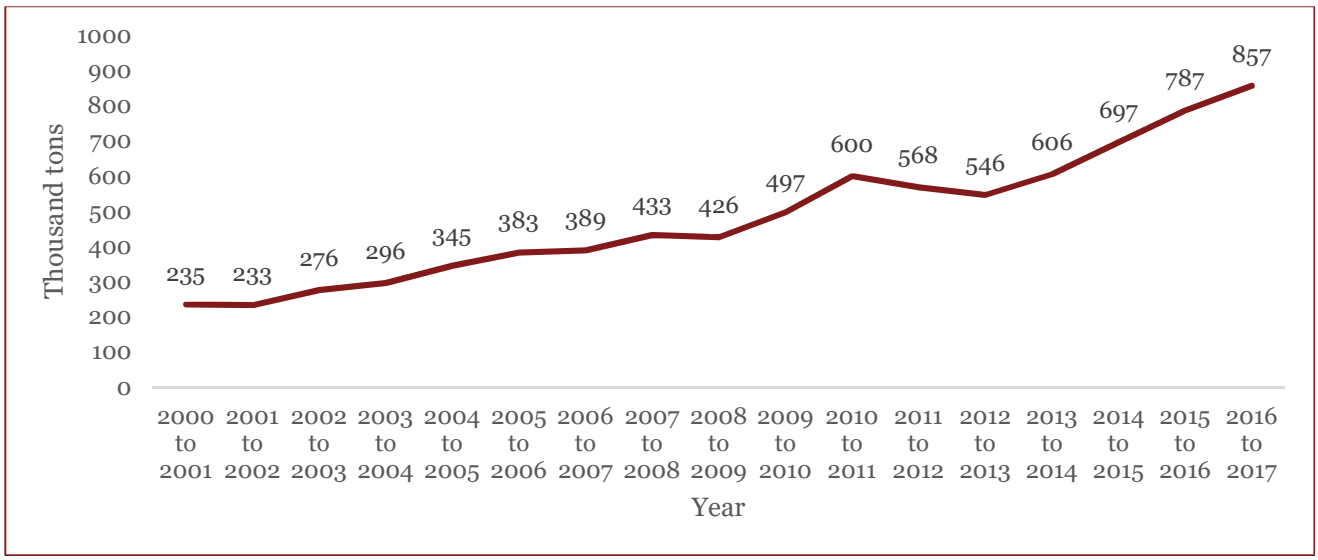
Table 4: Summary of aviation sector trends, historical growth rates

Passenger Traffic	5 year historical	10 year historical
Global	5.7%	5.8%
India	10%	10.6%
Delhi NCR	10%	10.9%
Cargo Handling	5 year historical	10 year historical
Global	1.2%	2.7%
India	5.4%	8.2 %
Delhi NCR	8.6%	8.6%

Source: DGCA, World Bank, PwC analysis

Cargo handling at IGI Airport has also been increasing over the years. During 2011-12 to 2016-17, cargo handling at IGI airport has increased from 568 thousand tons annually to 857 thousand tons annually – a CAGR of ~ 8.6 percent.

Figure 21: Air cargo handling at IGI Airport, thousand tons annually



Source: AAI

Considering the growing air traffic, capacity expansion of around 160 billion INR is planned at IGI airport. This expansion project includes upgradation, development and construction of facilities to

achieve airport capacity of about 109 million passenger per annum and 2.2 million tons per annum of cargo by 2034. Despite the capacity expansion, IGI airport is likely to reach its stated capacity in the near future.

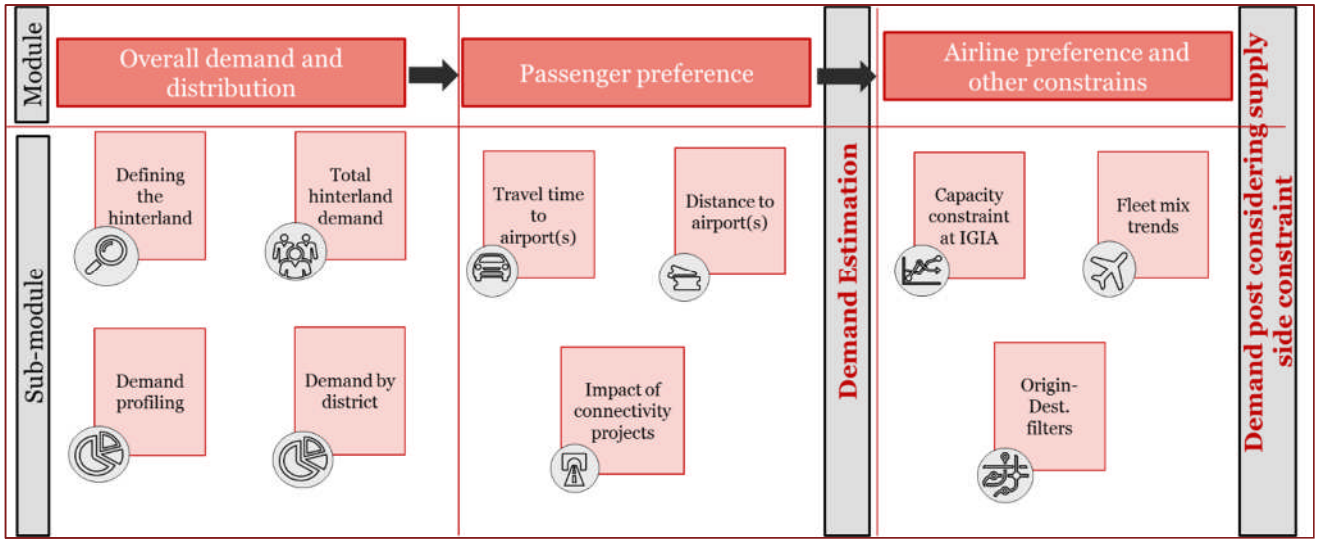
Capacity constraint at IGI along with the horizontal expansion of Delhi city has necessitated requirement of a new airport. The next section discusses the potential traffic at the proposed airport and likely impact of the capacity constraint at IGI on the proposed airport's traffic (see Section 4.4).

4. Potential traffic at Jewar

4.1. Approach and methodology

A modular approach is followed to estimate traffic at the proposed airport at Jewar. Three broad modules with multiple sub-modules are followed for traffic estimation (Figure 22).

Figure 22: Approach and methodology for passenger traffic estimation at proposed Jewar Airport



Module 1 (Overall demand and distribution): Multi-variable linear and logarithmic regression models are used to predict the future air travel demand at IGI airport. Crude oil prices, historical GDP growth rate of India and the world economy are the key factors used for predict the demand. Since IGIA is the only large international airport serving Delhi NCR, the traffic at IGI reflects the total hinterland demand.

The estimated demand is further divided amongst the various districts that constitute IGI's hinterland. To determine the districts constituting IGI's hinterland, a detailed 24 hours survey was undertaken at IGI airport. Covering a random sample of over 6,000 travelers, the survey supported in answering the following questions:

- **Origin and destination of passengers:** Districts from where the passengers are coming to IGI airport & what is their ultimate destination.
- **Profile of the passenger:** Whether people are traveling for business purpose or for leisure?

Inputs from the survey supports to demarcate the catchment area/hinterland serviced by IGI airport and also provide an estimation on the volume of traffic moving from these identified regions.

Module 2 (Passenger preference): Since the proposed airport is expected to compete with the existing IGI airport, a detailed assessment is undertaken to determine the division of traffic between the two airports. Distance and the time spent from the identified districts in the hinterland to the two airports are studied to evaluate passenger preference.

Hour of travel is recognized to have a strong correlation with the time spent on traveling to the airport. For instance, early morning a passenger from Noida may prefer taking a flight from IGI than compared to Jewar. However, the choice of airport may change if we consider a peak hour evening slot. The time of time travel, considering different time slots-morning 6 am, 8am, 5pm and 8pm- is considered while evaluating the passenger choice of the airport.

Similarly, impact of upcoming connectivity projects such as Khurja-Palwal Expressway, Eastern Peripheral Expressway, expansion of Palwal Aligarh expressway, etc., have also been considered in determining the preferred airport.

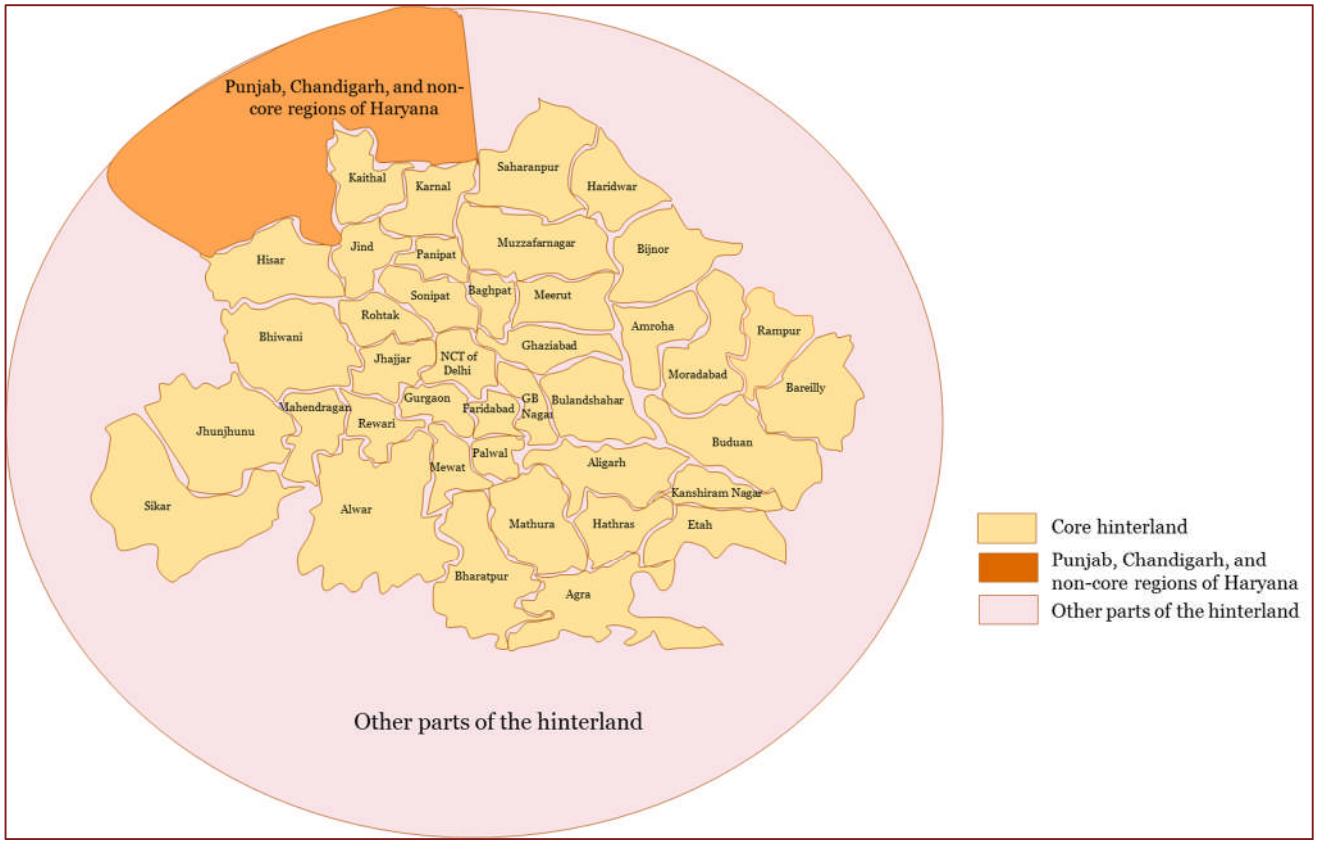
Module 3 (Airline preference and other constraints): For an airline to start operations for a particular route it may require a minimum threshold traffic. An airline would start operations at Jewar airport only when there is sufficient traffic for the airline to start a regular operation. In the absence of air connectivity, the traffic that may lie in the hinterland of Jewar airport may still shift back to IGIA.

In addition, slot and capacity constraints at IGIA, especially at peak hours, may result in spill of traffic from IGIA to the airport at Jewar. Therefore, a detailed evaluation of IGIA's capacity has been undertaken to estimate potential traffic at the proposed airport.

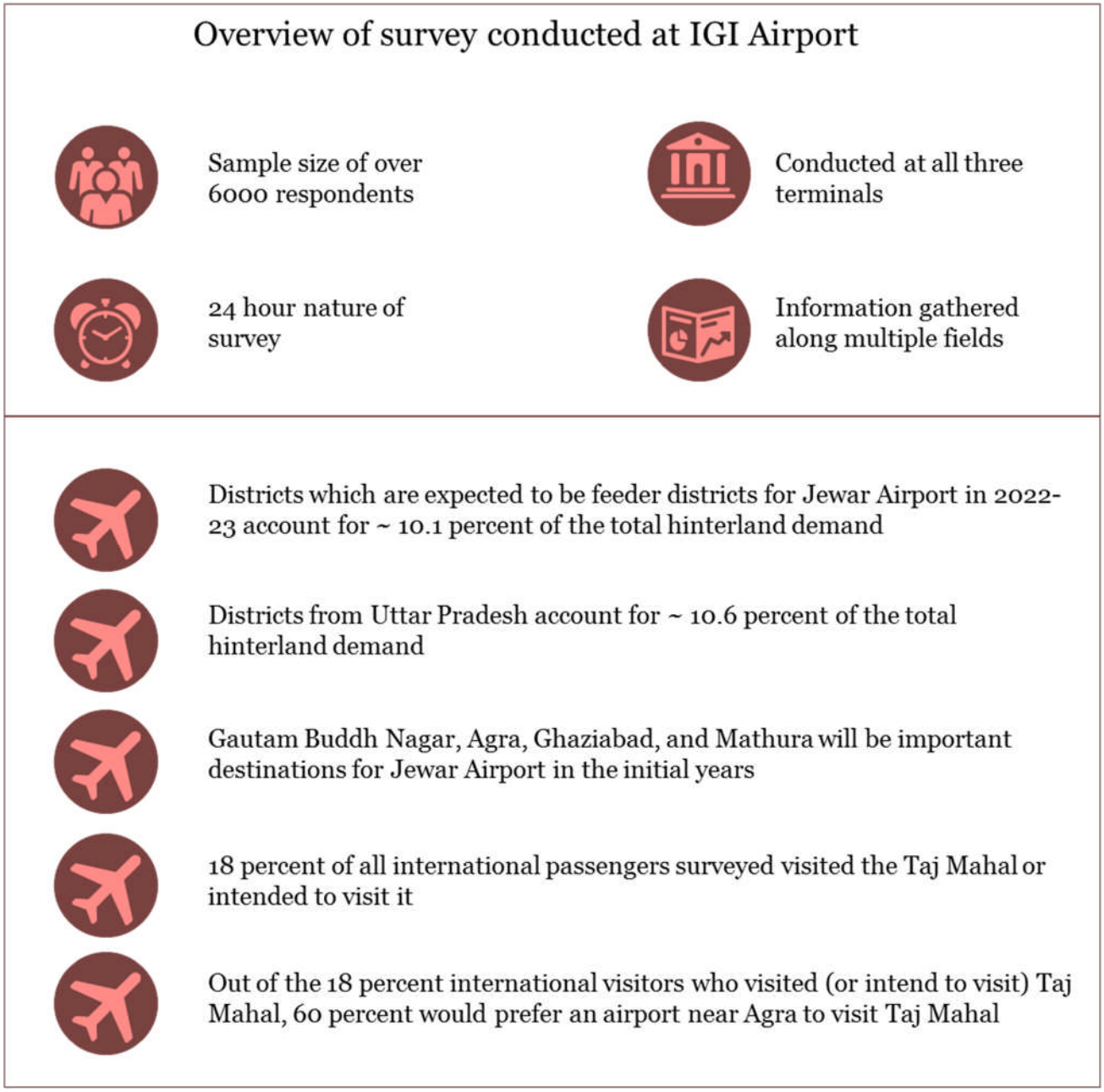
4.2. Module 1: Overall demand and distribution

The catchment area/hinterland of the dual airport system in NCR region is divided into three broad categories. The primary hinterland comprises of all the districts that lie within a 150 km radius from the dual airport system. This includes 50 districts spread across NCT of Delhi, Haryana, Uttar Pradesh, Rajasthan, and Uttrakhand. The secondary hinterland consist of areas in Haryana (beyond 150kms radius), state of Punjab, and the Union Territory of Chandigarh. Due to high levels of economic activity in these regions, they account for a considerable share of demand generated at IGI Airport. The third part comprises of regions not included in the first and second part. Some of the major demand drivers of the third part are the state of Himachal Pradesh, Jammu & Kashmir, and regions of Uttarakhand outside the core hinterland.

Figure 23: Hinterland of the dual airport system



As discussed, to obtain a comprehensive view of the hinterland, a detailed 24 hours survey was undertaken. The survey covered a sample of around 6,000 passengers, across the three terminals of IGI airport. The box below provides the key finding of the survey.

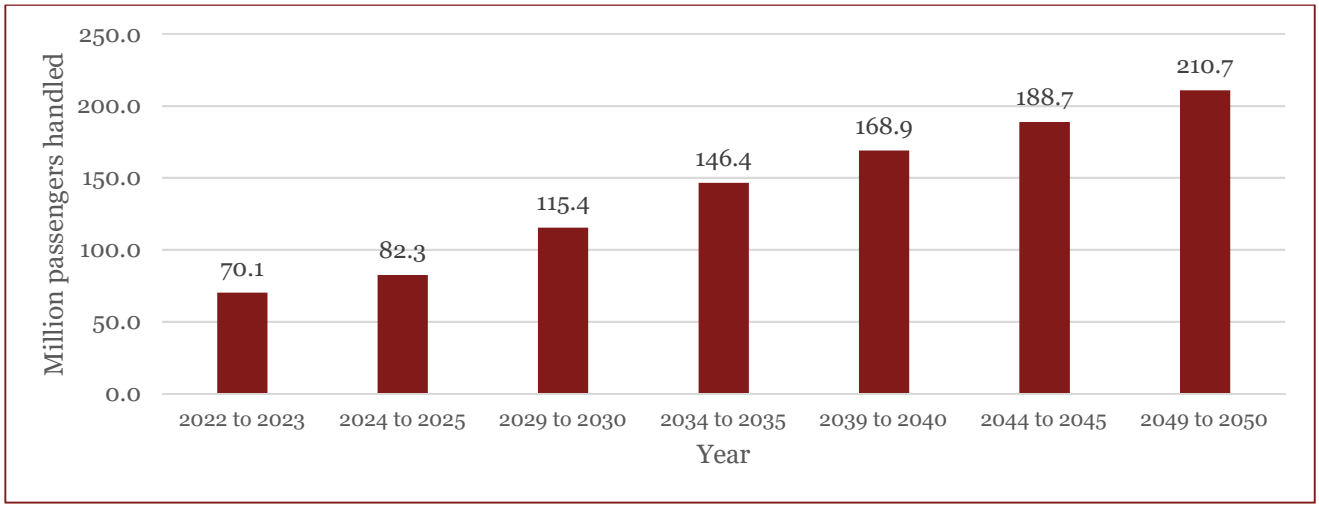


4.2.1. Hinterland demand estimation

Currently, IGI airport is the only large airport serving NCR hinterland as well as catering the air travel demand of other neighboring states. As highlighted in Section 3.2.1, during 2011-12 to 2016-17, domestic passenger movement at IGI grew at a CAGR of 11% (Figure 20). The growth of domestic air travel demand from IGI's hinterland is expected to continue to grow on the strong growth trajectory. Regression models (see Annexure B.3 for details) reveal that by 2022-23 the domestic traffic from the

hinterland is expected to reach ~70 million and by 2029-30 it is expected to reach ~115 million. By 2050, the domestic traffic from the hinterland is expected to reach ~ 210 million.[2]

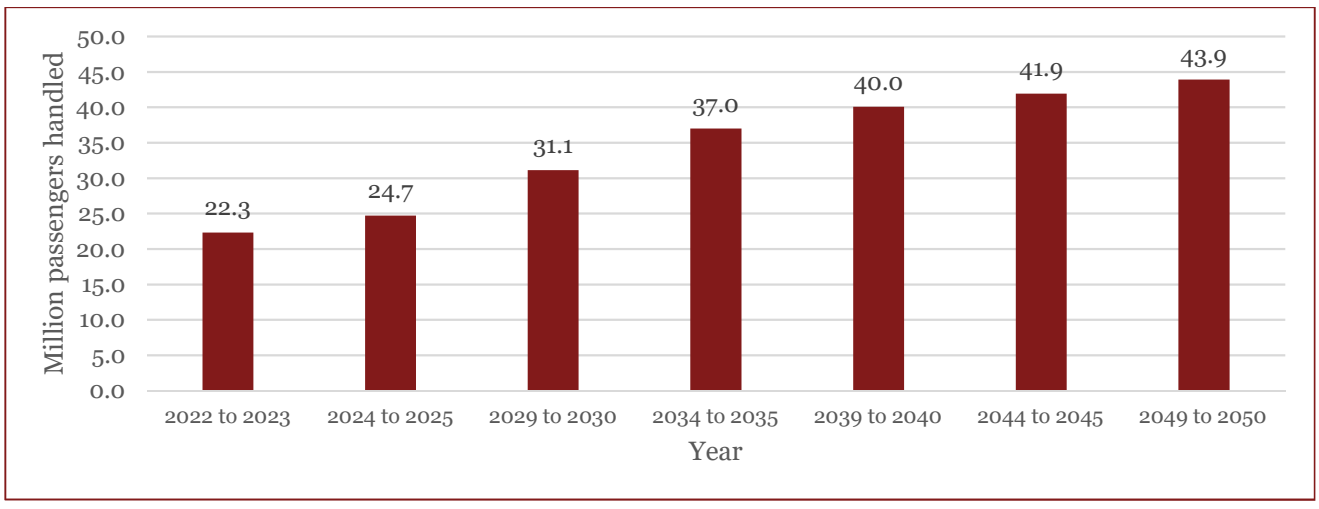
Figure 24: Demand for domestic air travel from the hinterland, million passengers handled annually



Source: PwC analysis

Similarly, international passenger demand from IGI's hinterland is also likely to continue its growth momentum. Regression results (see B.3 for further details) highlight that by 2022-23 the international traffic from the hinterland is expected to reach ~22 million and by 2029-30 it is expected to reach ~31 million. By 2050, the international traffic from the hinterland is expected to reach ~ 44 million.[3] Details of total hinterland traffic demand have been presented in Appendix D. -.

Figure 25: Demand for international air travel from the hinterland, million passengers handled annually



Source: PwC analysis

[2] Traffic mentioned is in terms of passenger handling
[3] Traffic mentioned is in terms of passenger handling

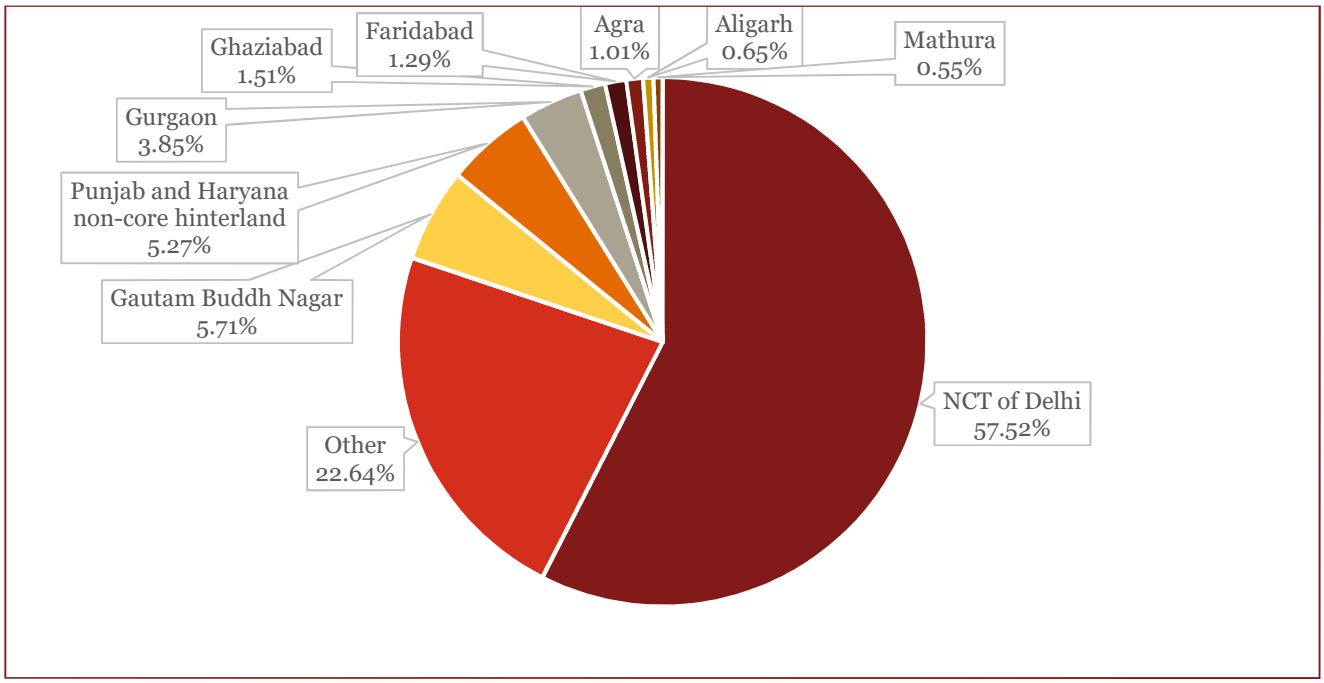
Estimates reveal that the overall air travel from the hinterland is expected to double in the next 8 to 10 years. It is expected to rise from 63 million annual passenger handling in 2017-18 to ~130 million annual passenger handling in 2027-28. In subsequent decades, the growth is likely to continue and the overall air travel demand from the hinterland expected to reach to about 250million annual passengers handled by 2049-50.

4.2.2. Hinterland identification and distribution

To determine the hinterland catered by IGI airport, a detailed 24 hours survey for three days was conducted at the IGI Airport. The survey covered the three terminals of IGI Airport and it covered a sample set of over 6,000 passengers. The aim of the survey was to determine OD pattern of the passengers using IGI Airport.

Based on the survey results and international tourism distribution numbers, it has been identified that almost 57 percent of the passengers using IGI Airport are from NCT of Delhi, followed by districts/regions like Gautam Buddh Nagar (~ 5 percent), Gurgaon (~ 4 percent), Agra (~ 1 percent), Punjab and Haryana non-core regions (5 percent), and Ghaziabad (~ 1.5 percent). Given IGIA is a major airport in the region, a significant portion of passengers at IGIA come from different parts of the country including Shimla, Sri Nagar, Jammu, etc. (categorized as 'Other' in Figure 26).

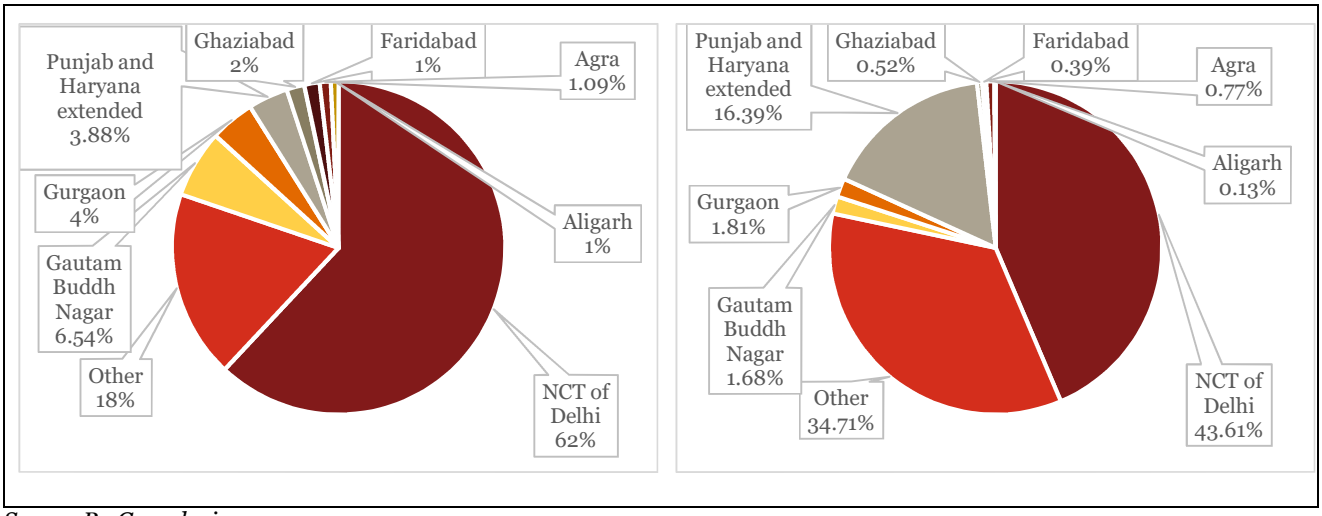
Figure 26: Hinterland catered by IGI airport



The distribution is broadly similar even we analyze the domestic and international passenger separately. However, in case of international movement, traffic movement from non-core hinterland Punjab and regions of Haryana, at ~ 17 percent of the hinterland's international demand, is second to

NCT of Delhi whereas share of districts from UP is only about 4-5 percent (compared to ~ 12 percent in case domestic traffic).

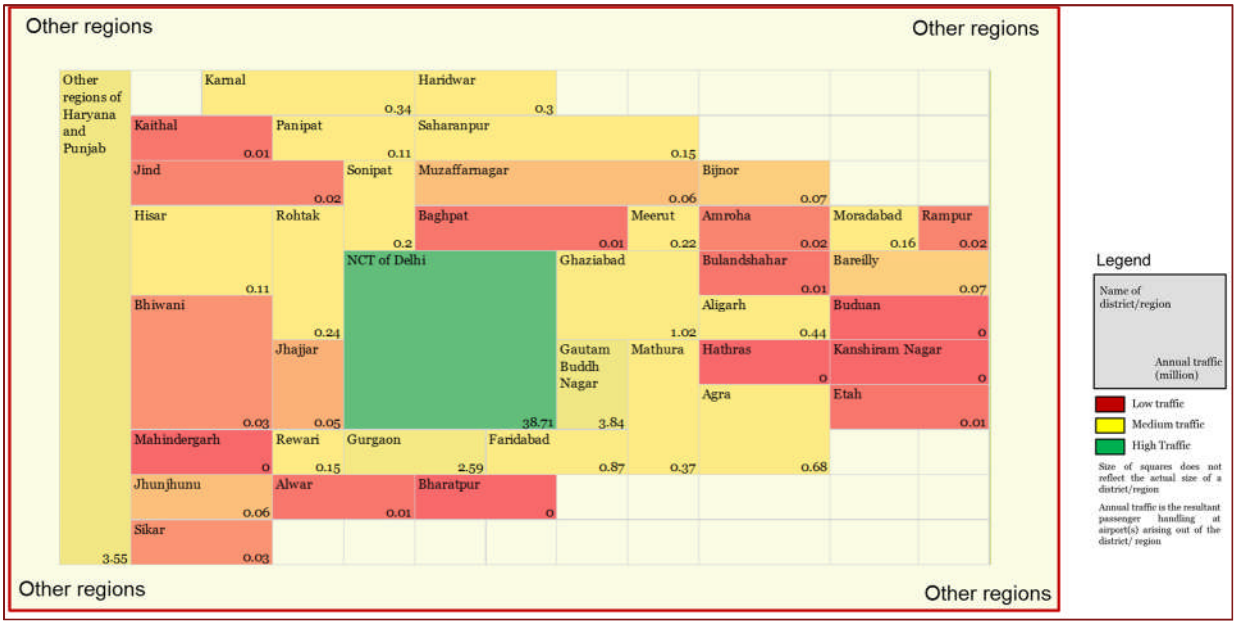
Figure 27: Hinterland movement: domestic passengers (left) and international passenger (right)



Source PwC analysis

The share in case of domestic passenger movement is different as districts of UP account for nearly 11-12 percent of the total passenger movement at IGI airport. Regions like Agra, Gautam Buddh Nagar, Meerut, Ghaziabad, Mathura, Aligarh, etc., are expected to be major contributors to the traffic. Figure 28 provides distribution of traffic expected in 2018-19 amongst the key districts/regions identified from the survey. Hence the survey data provides a comprehensive view of the hinterland as well as the air traffic demand from these districts.

Figure 28: Expected distribution of hinterland traffic generation in 2018-19

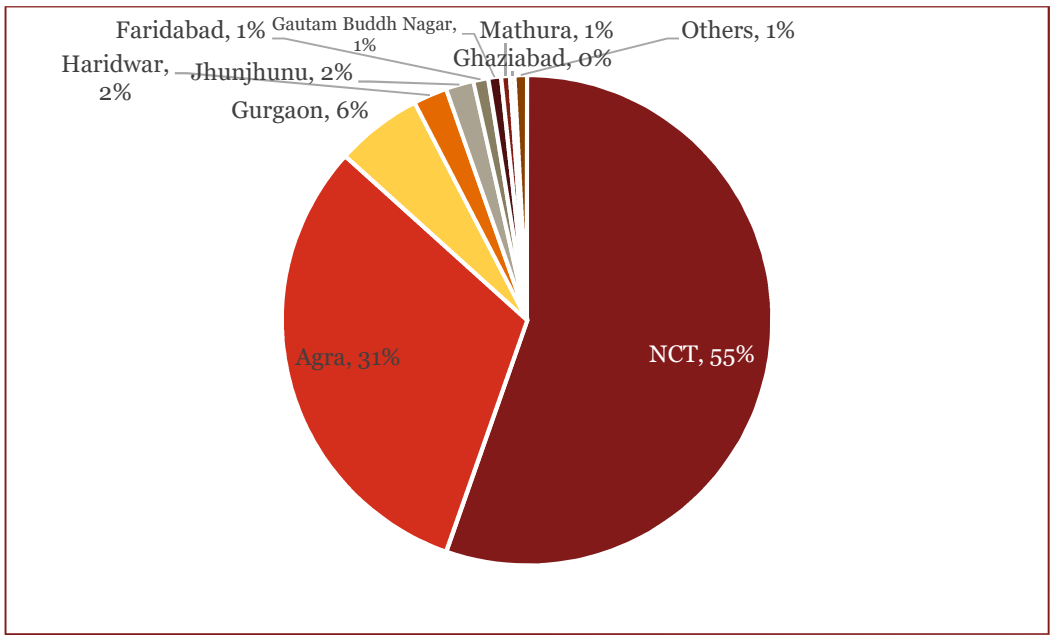


Note: Other regions are expected to account for 12.75 million of annual traffic generation in terms of passenger handling
Source: PwC analysis

It is interesting to note that share of famous tourist destination like Agra is relatively low in the survey. This is largely because typically tourist have multi city itineraries of which Agra and NCT of Delhi are often a part. The OD survey often may not reflect the right picture. For instance, tourist coming to visit the Taj Mahal often visit other areas of Delhi. They may spend their first and last leg of NCT Delhi. Such travelers may get reflected as passengers originating/ terminating in NCT of Delhi even if they might have spent more time in other tourist destinations like Agra. Hence, as part of the survey, it was asked whether Agra was part of travelers' itinerary or not. Also if the travelers would prefer an airport near Agra. The response to the survey revealed that about 18% of the international passengers expressed their intent to visit Agra as part of their trip. Out of these, around 60% revealed the preference for an airport near Agra.

Given these trends, estimation of the potential international tourist origin (or destination) is based on the actual tourist arrival data rather than the OD survey. Actual tourist footfall provides a better picture on the pattern of air travel demand. As shown in Figure 29, NCT of Delhi, Agra and Gurgaon are the three key destinations visited by foreign tourist. Therefore foreign tourist arrival at the airport is expected to follow similar distribution pattern across different districts. This tourist distribution pattern is in-line with the survey result of around 18% of the international travelers (including non-tourist travelers) having visited or having intent to visit Agra.

Figure 29: Foreign tourist arrivals, share of districts in total footfall



Source: Secondary research

The above distribution pattern provides is used as an input to provide an approximation of typical international air travel demand across different districts. As expected, second to NCT of Delhi, Agra is one of major drivers of international air travel demand in the hinterland.

Given the air travel demand, the next section discusses the parameters that may influence the choice of the one airport over another.

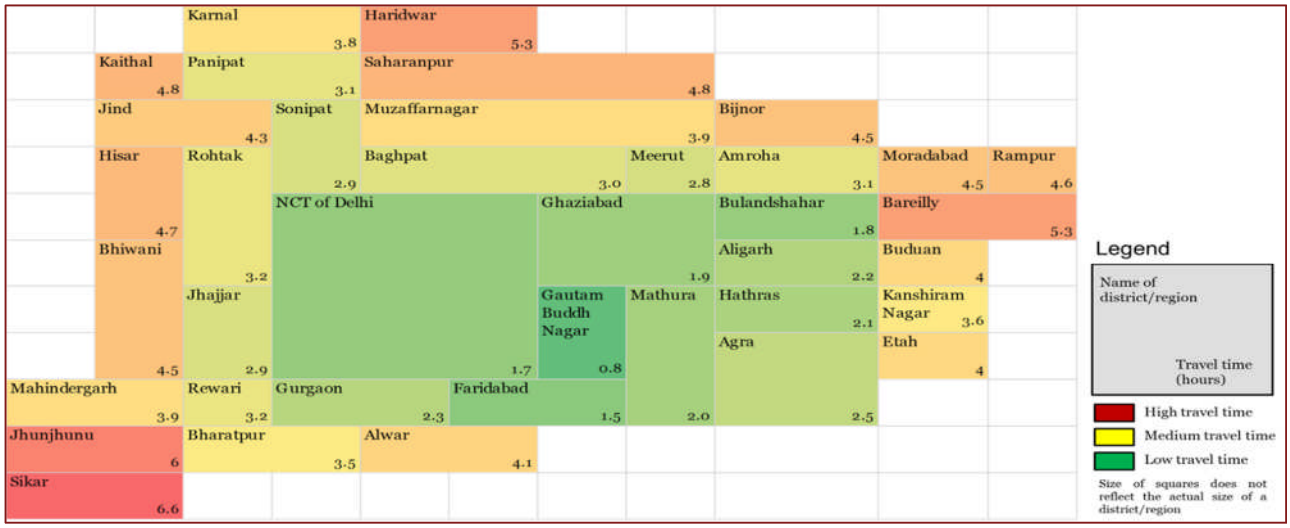
4.3. Module 2: Passenger preference

Travel time to and from the airport is expected to be one of the major determinant for passenger's airport preference. Figure 30 and Figure 31 depict the travel time from Jewar and from IGI Airport respectively to the districts of the hinterland. In addition, distance between the districts of the hinterland and the airports is used as a proxy for cost of travel from the respective to districts to each of the airport.

The following broad observations were made upon analysis of travel time and distance:

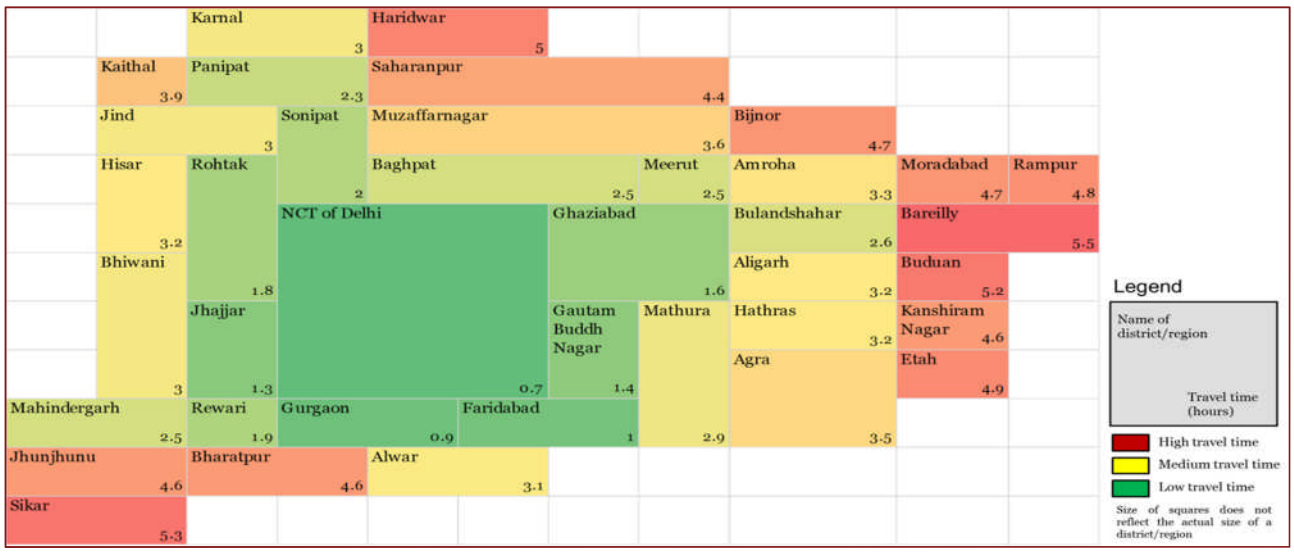
- Upon comparing Figure 30 and Figure 31, it may be observed that most of the districts in Uttar Pradesh sub-region of the hinterland may have lower travel time to Jewar Airport compared to IGI Airport. Out of those districts, the ones located in the south of UP may have significant time advantage. For example, travel time from Agra to IGI Airport is 3.5 hours compared to 2.5 hours for Jewar Airport. Similarly, some of the other regions such as Mathura, and Aligarh show an absolute time advantage in favor of Jewar than compared to IGI airport.
- In case of districts where the travel time to the two airports is not significantly different, we expect passenger to prefer IGI Airport. However, the scenario may change with improvement in connectivity to the proposed Jewar airport. For instance, passenger moving from Ghaziabad may take 1.9 hours to Jewar compared to 1.7 hours for IGI Airport. However, post operation of Eastern Peripheral Expressway the travel time may significantly reduce. Similarly, development of Palwal Khurja expressway may also divert passenger movement from Faridabad to Jewar.
- Districts located more than 150 km from both the airports may prefer using IGI Airport over Jewar airport. This is because passengers traveling more than 150 km may prefer using rail or bus to travel to/from the airport, for which IGI Airport is better suited because of the better rail network at Delhi.
- Districts in Haryana, especially the ones located west (such as Kaithal, Jind, and Panipat), may prefer using IGI Airport over airport at Jewar due to the close proximity to the former airport.

Figure 30: Travel time from hinterland's districts to Jewar



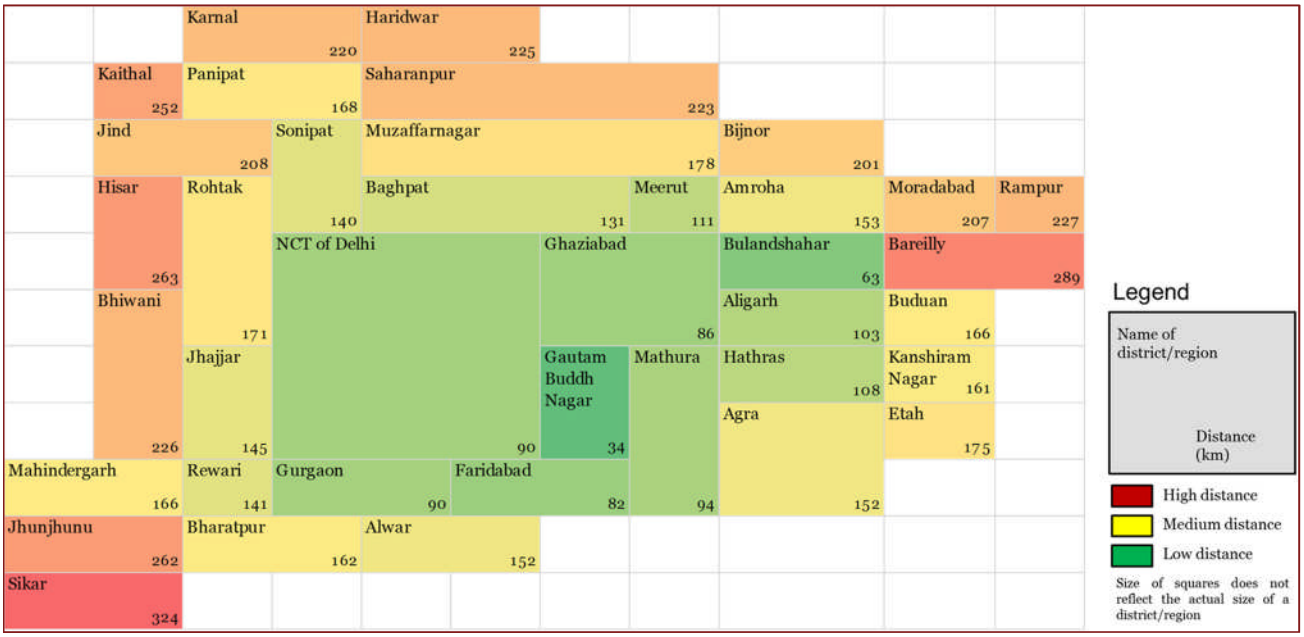
Source: Google maps, PwC analysis

Figure 31: Travel time from hinterland's districts to IGIA



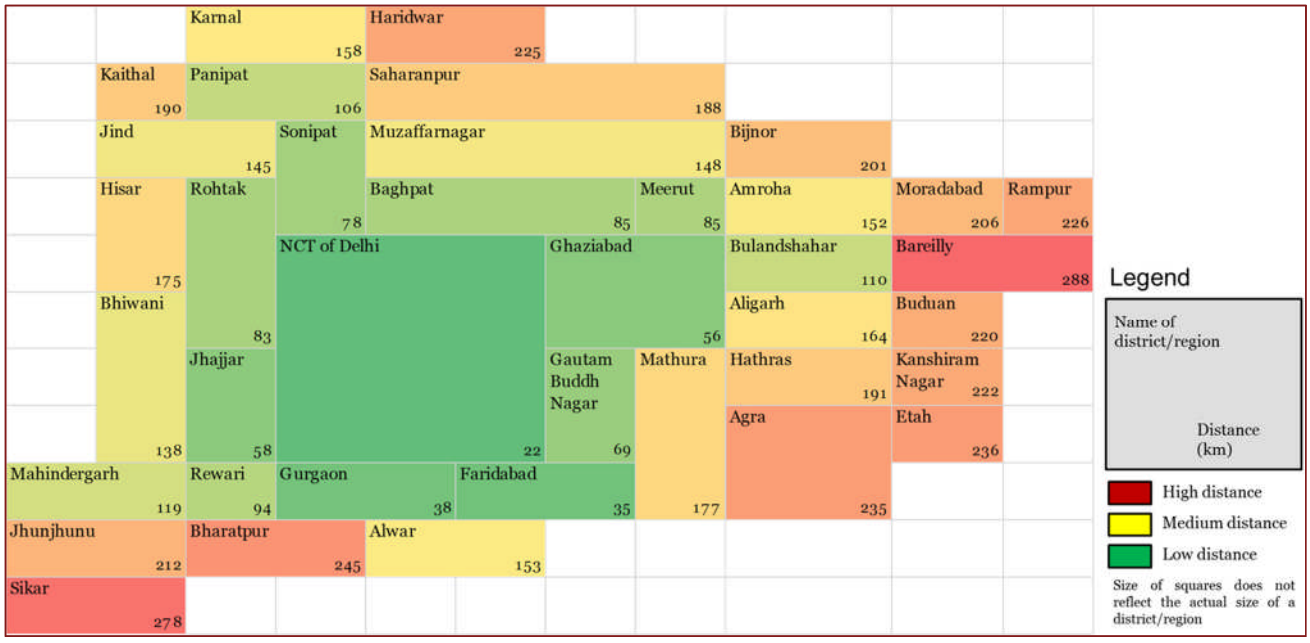
Source: Google maps, PwC analysis

Figure 32: Distance from hinterland's districts to Jewar, in km



Source: Google maps, PwC analysis

Figure 33: Distance from hinterland's districts to IGIA

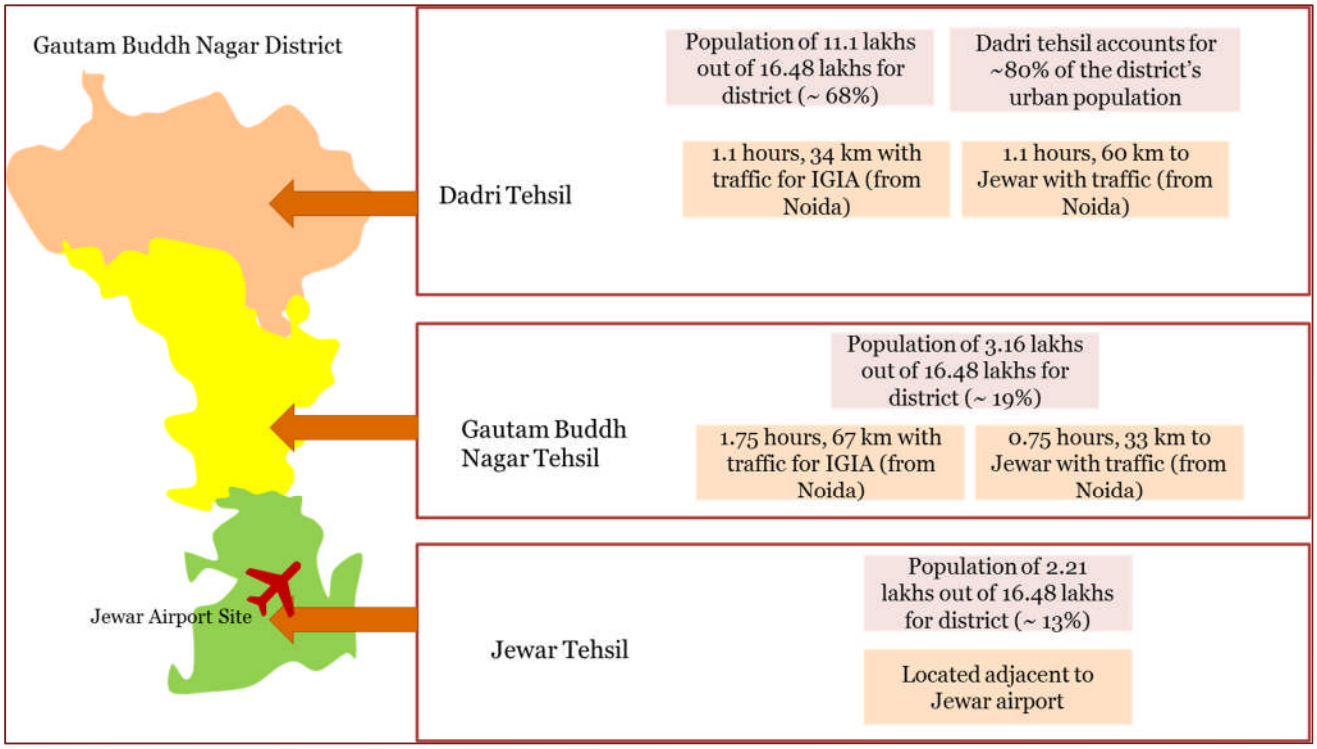


Source: Google maps, PwC analysis

- Proposed airport at Jewar has both a time and distance advantage for Gautam Buddh Nagar when distances and travel times are measured from the geographical center of the district. However, the population distribution within the district has a greater concentration in the northern parts of the district. The northernmost tehsil, Dadri Tehsil, contains the important urban center of Noida and contains 80 percent of the district's urban population. From Noida, the travel time to IGI Airport and Jewar Airport are comparable. However, IGI Airport enjoys a distance advantage of nearly 25 km. Thus, Noida region

will have a greater tendency to be served by IGI Airport till connectivity projects like metro link from Noida to Jewar Airport are made. It may also be noted that in the future as traffic on the way to IGI Airport from Dadri Tehsil increases, the preference for Jewar Airport is likely to go up. The other two tehsils of the district- Gautam Buddh Nagar Tehsil and Jewar Tehsil, enjoy a clear time and distance advantage for Jewar Airport.

Figure 34: Time and distance analysis of Gautam Buddh Nagar District



4.3.1. Unconstrained demand at the airports

Based on travel time and distance considerations, the core hinterland of the dual airport system has been divided into three categories:

- IGIA's exclusive hinterland
- Jewar Airport's exclusive hinterland
- Hinterland common to both airports

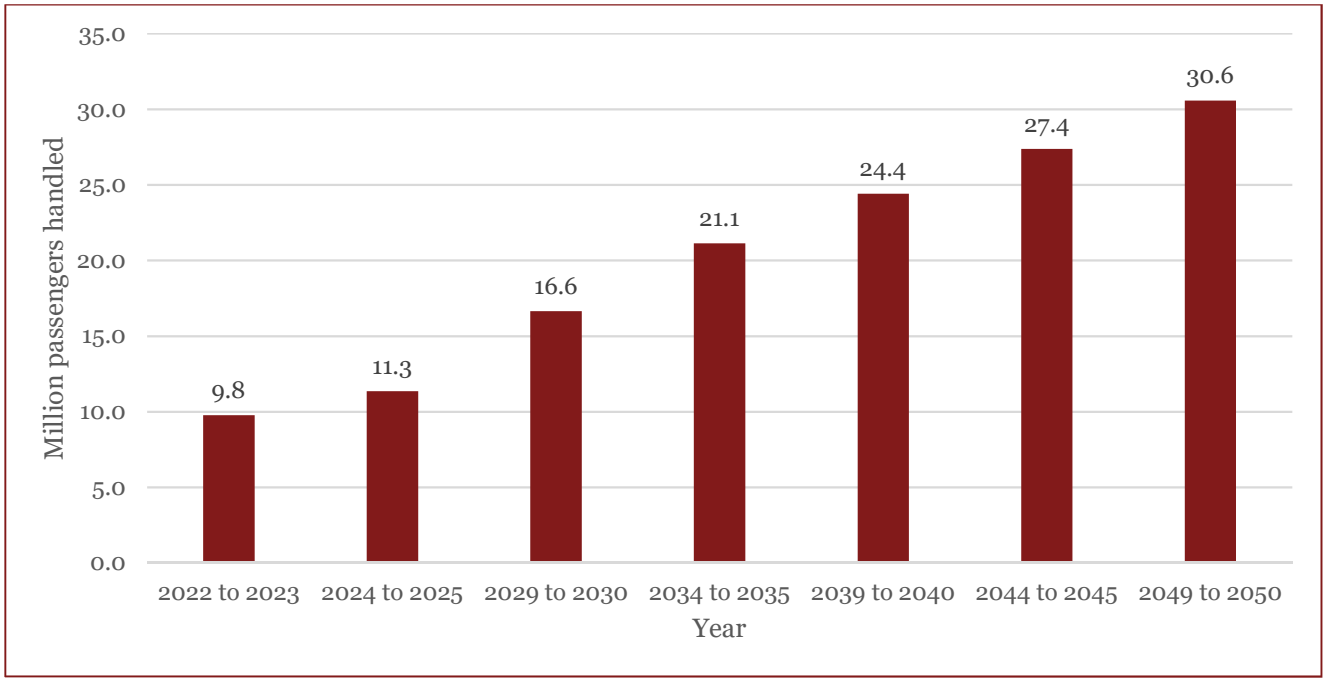
Figure 35 depicts the allocation that has been made. Details of the allotment are present in Appendix C.3.

Figure 35: Allocation of core hinterland districts to airport(s)

Source: PwC

Air traffic demand from the exclusive hinterland of Jewar provides an unconstrained demand for the proposed airport. As per the demand trend revealed in the survey, unconstrained demand from the exclusive hinterland of Jewar is expected to be approximately around 10 million in 2022-23 and reach ~ 30 million by 2049-50. The unconstrained demand is however not the actual realizable traffic as it only provides demand perspective without taking into consideration supply side perspective in-terms of airline preference and capacity issues of the dual airport system.

Figure 36: Unconstrained demand for passengers at Jewar Airport, million annually



Source: PwC analysis

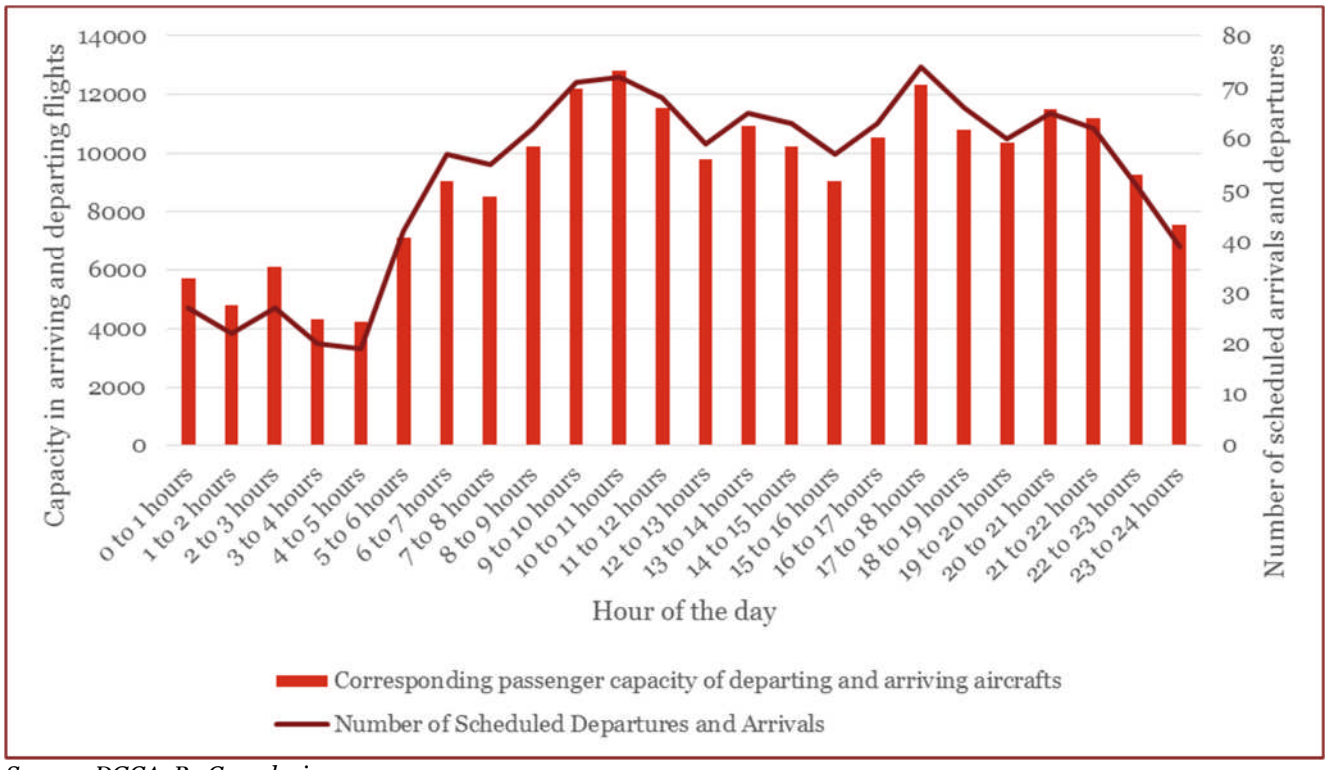
4.4. Module 3: Supply side constraint

4.4.1. Capacity at IGIA

Capacity constraint at IGI Airport may significantly influence the traffic movement at Jewar. Upon completion of the fourth runway, IGIA will have two independent runways and another set of cross runways- effectively functioning with three independent runways. It has been observed globally that for multi-runway systems at busy airports the maximum hourly capacity per runway is 40 aircraft movements. Some notable examples are Hartsfield- Jackson Atlanta International Airport and Douglas International Airport which have a per runway capacity of 40 aircraft movements per hour under marginal conditions. Thus, IGIA is expected to be able to handle a maximum of 120 aircraft movements per hour. Any additional demand will act as a potential demand for a new airport in NCR

Figure 37 depicts the current pattern of scheduled aircraft movement at IGI Airport. It is observed that IGI airport has two peaks in a day in- one at around 10 am and the other at around 6 pm. As traffic at IGIA continues to grow, it will be the traffic from these peak hours that may spill over to the proposed airport at Jewar.

Figure 37: Aircraft and passenger movement pattern at IGIA on a typical day

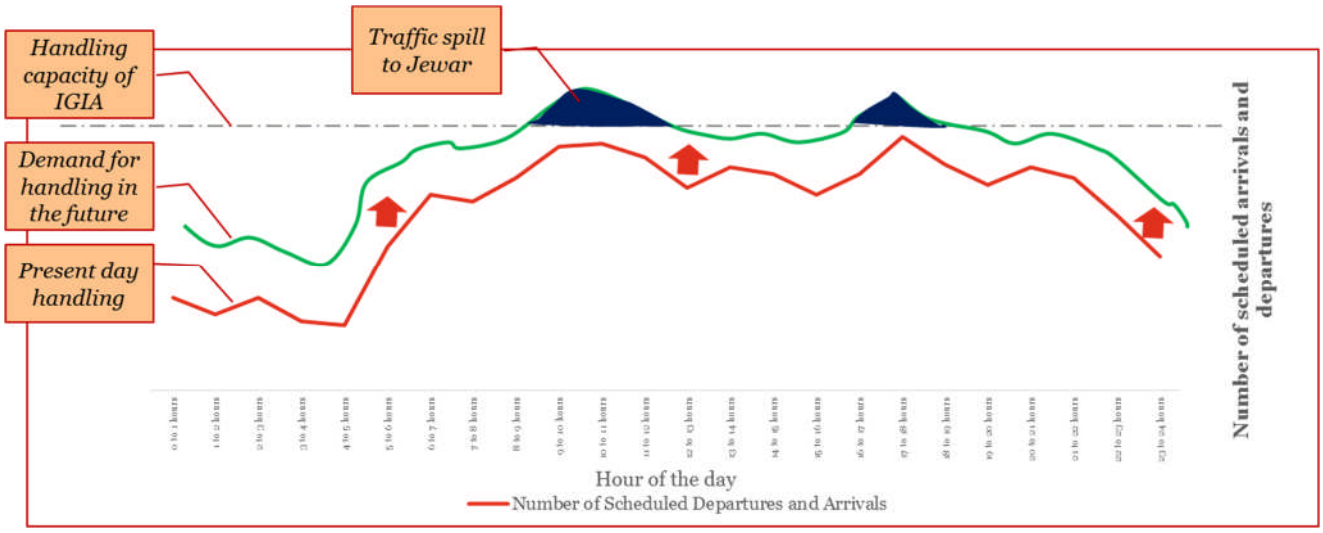


Source: DGCA, PwC analysis

This pattern of spill-over is depicted in Figure 38. It shows that with time, IGIA, it will be able to serve a smaller percentage on annual incremental demand increase, with a greater percentage of demand

being susceptible for spill to Jewar Airport. However, it is recognized that the runway constraint at the airport can be circumvent by the airlines by deploying wide body aircrafts for domestic routes, particularly on metro routes. This will help cater to demand for more passengers with fewer runway slots.

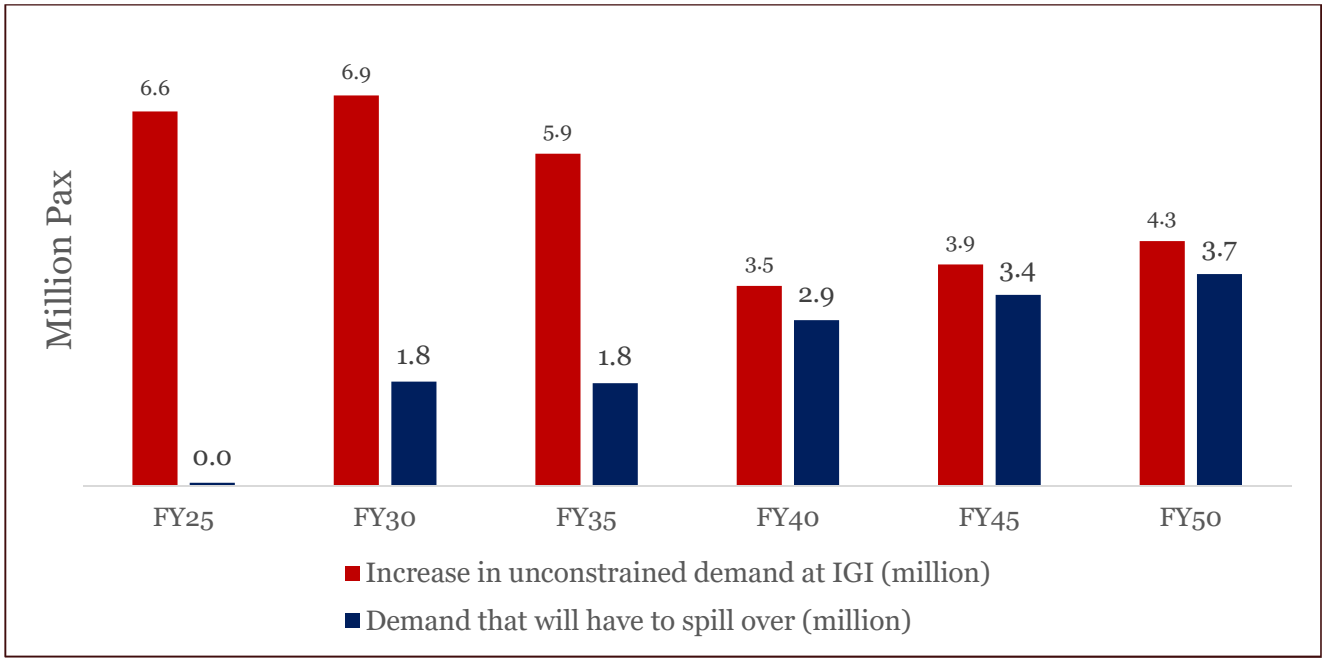
Figure 38: Pattern of traffic spill from IGIA to Jewar



Source: PwC

By 2025-26, traffic at IGI Airport is expected to be within its handling capacity. However, the airport is expected to witness capacity constraint at peak hours. This may result in spill-over of traffic to Jewar Airport. Thus, in the initial years, Jewar Airport is likely to cater to the peak hour demand of IGI and a sharper traffic profile. Over time as more number of hours at IGIA reach capacity, the slot allocation window at Jewar to accommodate spill-over flights will broaden. The potential spillover from IGI may start picking significant pace by 2029-30 as IGI reaches its capacity. Figure 39 provides the incremental demand at IGI Airport along with the potential spill-over to alternate airport.

Figure 39: Demand increase (incremental) at IGIA and year on year spill over to Jewar

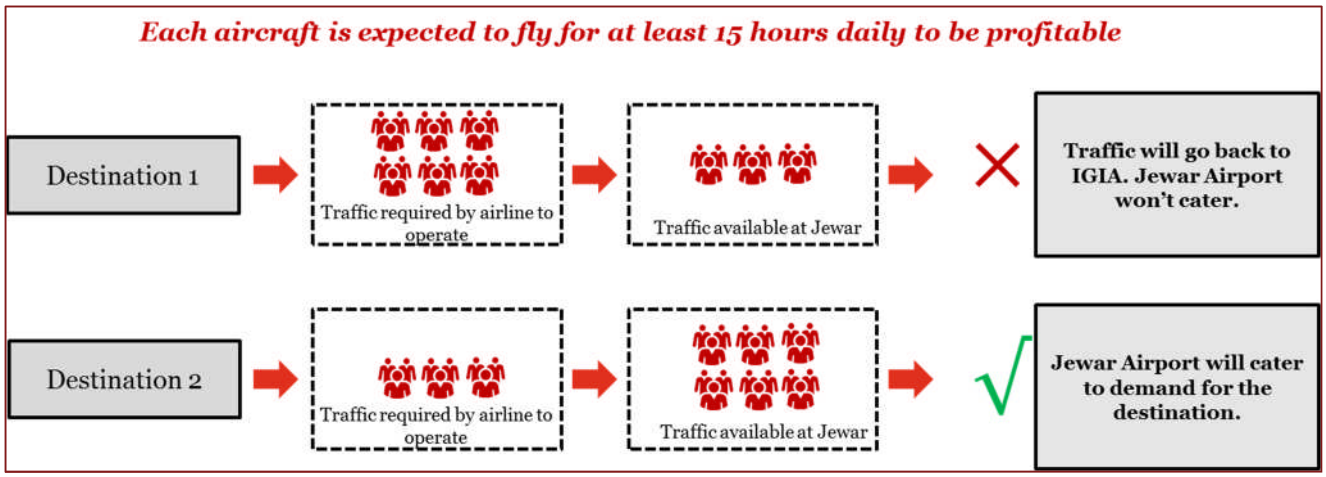


Source: PwC analysis

4.4.2. OD pairs and minimum threshold traffic requirement

Actual traffic at the airport would be determined by whether or not there are airlines providing scheduled services at the airport. In order to start services at an airport, airlines may seek a minimum threshold traffic so that an aircraft may be effectively deployed. In the absence of the minimum threshold traffic, certain routes will continue to be unserviceable. Thus, traffic that may be in the exclusive hinterland of Jewar would continue to fly from IGI airport. With increase in traffic, airlines may realize the minimum threshold traffic to start schedule services at the airport.

Figure 40: Concept of Origin-Destination threshold filter



Source: PwC

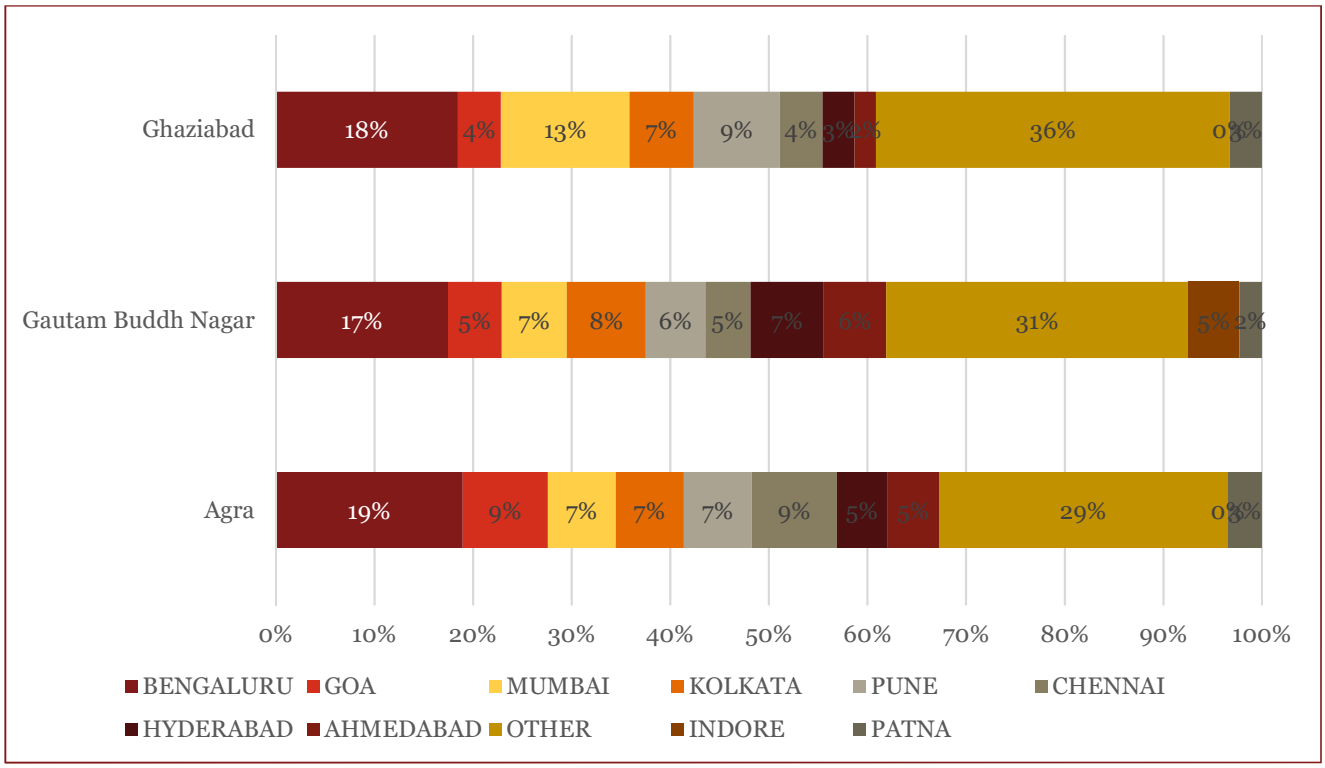
In order to determine the destinations that may be serviced at the proposed airport, it is important to evaluate the current travel demand of the districts in the hinterland of the airport. As per the survey conducted at IGI airport, typical OD demand for different districts is identified:

- OD pattern of Gautam Buddh Nagar District: Most air travel demand of the district is to/from metropolitan cities[4] (44 percent), followed by cities like Ahmedabad (6.3 percent), and Goa (5.4 percent).
- OD pattern of Agra: Movement to/from Agra is mostly to/from metropolitan cities. The other cities include Ahmedabad, Goa, Pune, Sri Nagar, Patna, Kochi, and Trivandrum. Together these movements account for 88 percent of the domestic traffic generation attributable to Agra.
- OD pattern of Ghaziabad: Similar to Gautam Buddh Nagar, the metropolitan cities have a 45 percent share. The remaining demand is more distributed as compared to regions like Agra and Gautam Buddh Nagar. Pune is a major destination for Ghaziabad, accounting for 8.7 percent of the demand.

[4] Mumbai, Bangalore, Kolkata, Chennai, and Hyderabad

- OD pattern of other districts in Jewar airport's hinterland: For other regions of the hinterland, the metropolitan cities' share remains at 44 percent.

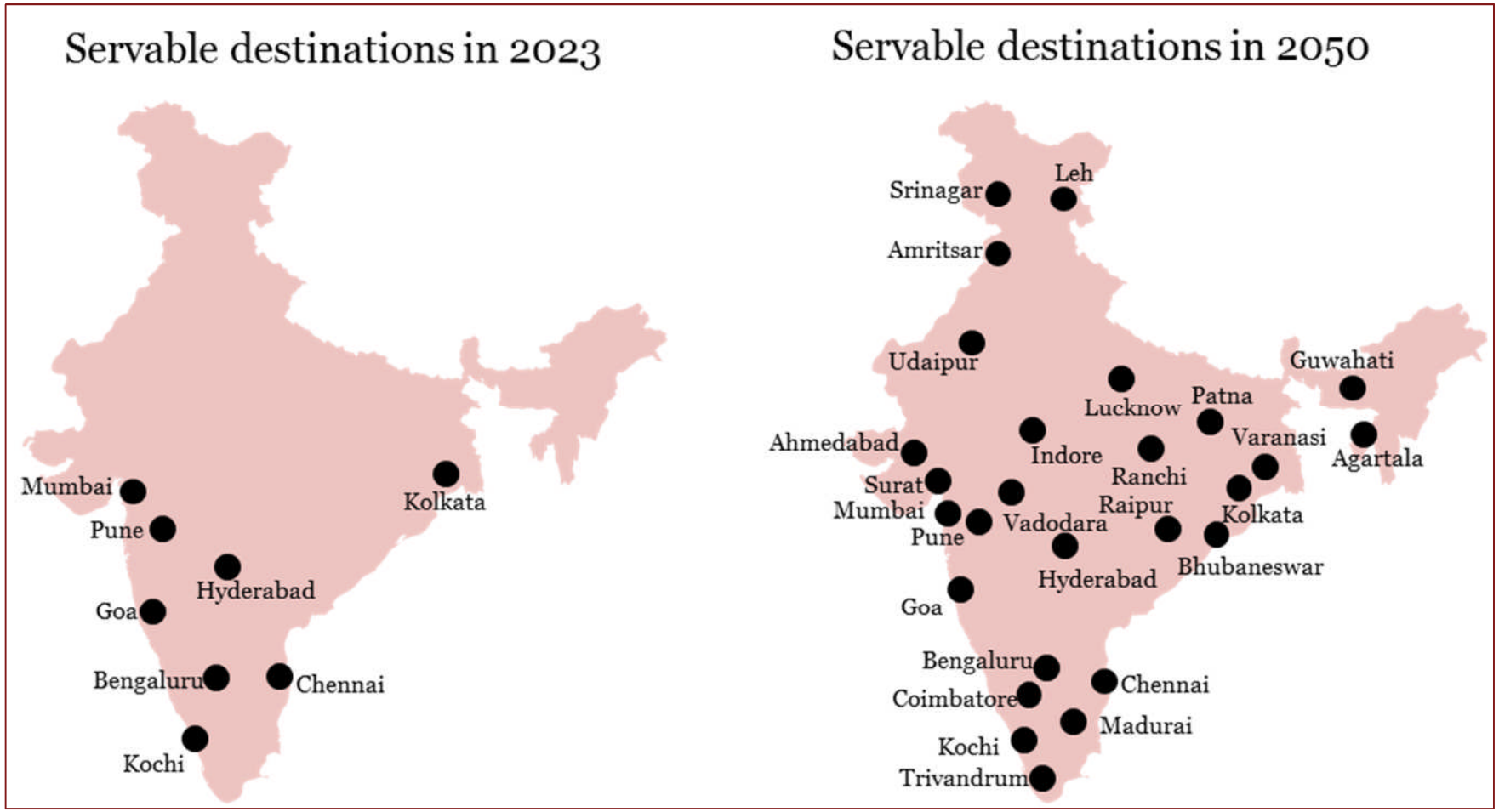
Figure 41: Distribution of traffic across different cities



40 percent of the overall demand of the hinterland is from the metropolitan cities of Mumbai, Kolkata, Bengaluru, Hyderabad, and Chennai. Given the pattern of demand, these are the initial few destinations that are likely to get scheduled service from the Jewar airport. By 2022-23, Jewar Airport may look towards serving 8 domestic destinations.

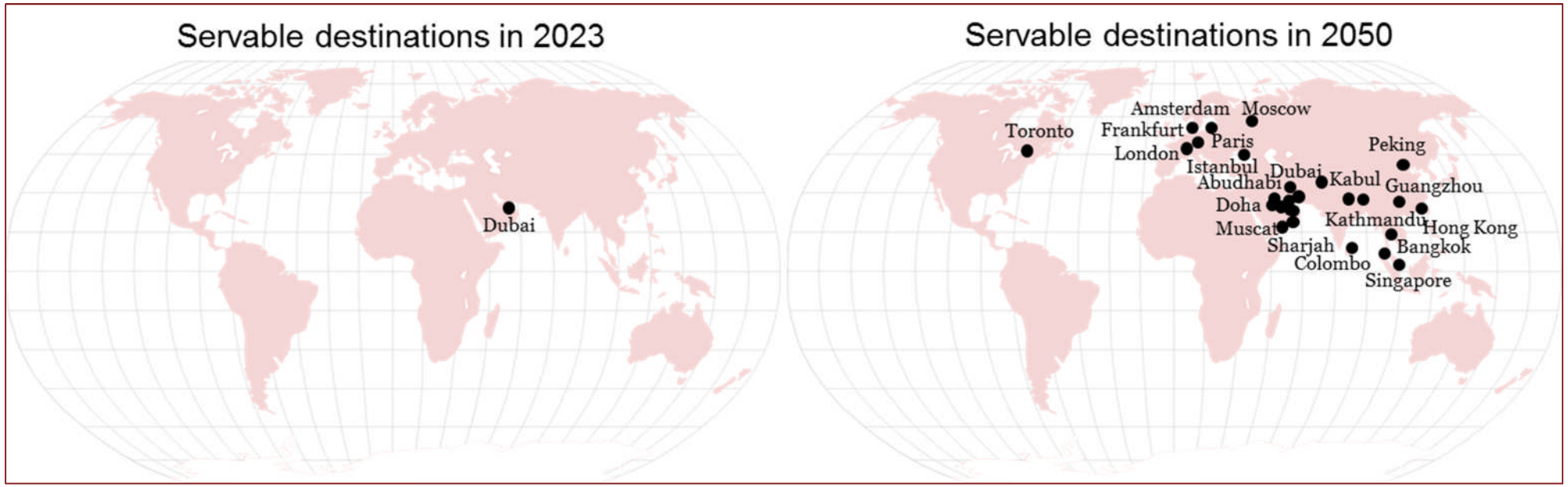
With respect to international destination, in the initial year, the airport may expect to serve Dubai. As IGIA reaches its capacity, it is expected that it will release its domestic slots in the initial years rather than the international slots. Therefore in the initial years, traffic at the new proposed airport is likely to be dominated by domestic air passenger movement. However, with increasing congestion at IGIA, international traffic may also start diverting towards the new airport. By 2050, Jewar Airport may look towards serving 27 international and 27 domestic destinations. Details regarding viability of origin-destination pairs have been presented in Appendix F. -.

Figure 42: Feasible domestic destinations from Jewar



Source: PwC

Figure 43: Feasible international destinations from Jewar



Source: PwC

4.5. Connectivity to the airport

The traffic movement at the proposed airport is closely linked to the connectivity it has with its catchment area. In the initial years, before IGIA reaches its saturation, improved connectivity of the proposed airport to its immediate hinterland would play a critical role in attracting traffic to the airport. As IGIA reaches its stated capacity, it will be important to enhance Jewar's connectivity to NCT of Delhi to ensure movement of traffic from Delhi to Jewar airport.

The subsequent sections discusses some of the critical connectivity projects that are either being planned or should be considered to improve the viability of the airport.

4.5.1. Connectivity Projects for hinterland connectivity

Currently, passengers from certain districts such as Meerut, Ghaziabad and Faridabad may find it convenient to move to IGIA instead of the proposed airport at Jewar. However, few of the upcoming connectivity projects may change the pattern and result in traffic movement to Jewar vis-à-vis IGIA.

- **Eastern Peripheral Expressway**: This Expressway, linking Palwal with Ghaziabad and Kundli running on the eastern side of Delhi, completes the ring system around Delhi. Its function is to enable bypass movements avoiding Delhi. Operationalization of the expressway would cut down travel time from districts like Meerut and Ghaziabad to Jewar Airport. From Ghaziabad, time taken from Eastern Peripheral Expressway to Jewar Airport would come down to 40mins-45mins compared to current time of 1 hour 30 mins.[5] Similarly, travel time from Meerut would also reduce to almost an hour from current two and a half hours travel time.

- **Palwal-Khurja Expressway**: Palwal is connected to Jewar via Palwal Aligarh road. It is approximately about 20kms away from Jewar but the current road condition results in more than an hour travel time. However, there is planned road connectivity between Palwal and Khurja, which will connect districts like Palwal and Faridabad. With the start of the expressway, the travel time from Faridabad to Jewar is expected to come to down to 45 minutes, a 30 minute time saving compared to IGIA. [6] Apart from Palwal-Khurja Expressway, Faridabad-Noida and Ghaziabad expressway would also connect Faridabad district to the proposed airport (approximate travel time of around 40 minutes).

- **Western Peripheral Expressway:** This Expressway is proposed to runs on the west of Delhi connecting Kundli, Manesar and Palwal. The first leg connecting Manesar and Palwal is

[5] Ghaziabad to Jewar: entry at Dasna for EPE; From Ghaziabad to Dasna Entry point - 9kms , time -20 mins from Dasna entry point to Jewar airport would be 30-40 kms . Time taken from Dasna around 20-25 mins.

[6] Travel from faridabad to Palwal -24 kms in 35 mins; enter Palwal Khurja Expressway- 15 kms- 10 min

already operational. Connectivity from Manesar to Palwal and from Palwal to Jewar (via Eastern Peripheral Expressway) would connect the airport to the industrial region of NCR. This connectivity would support in attracting traffic (particularly cargo traffic) to the airport from Manesar region.

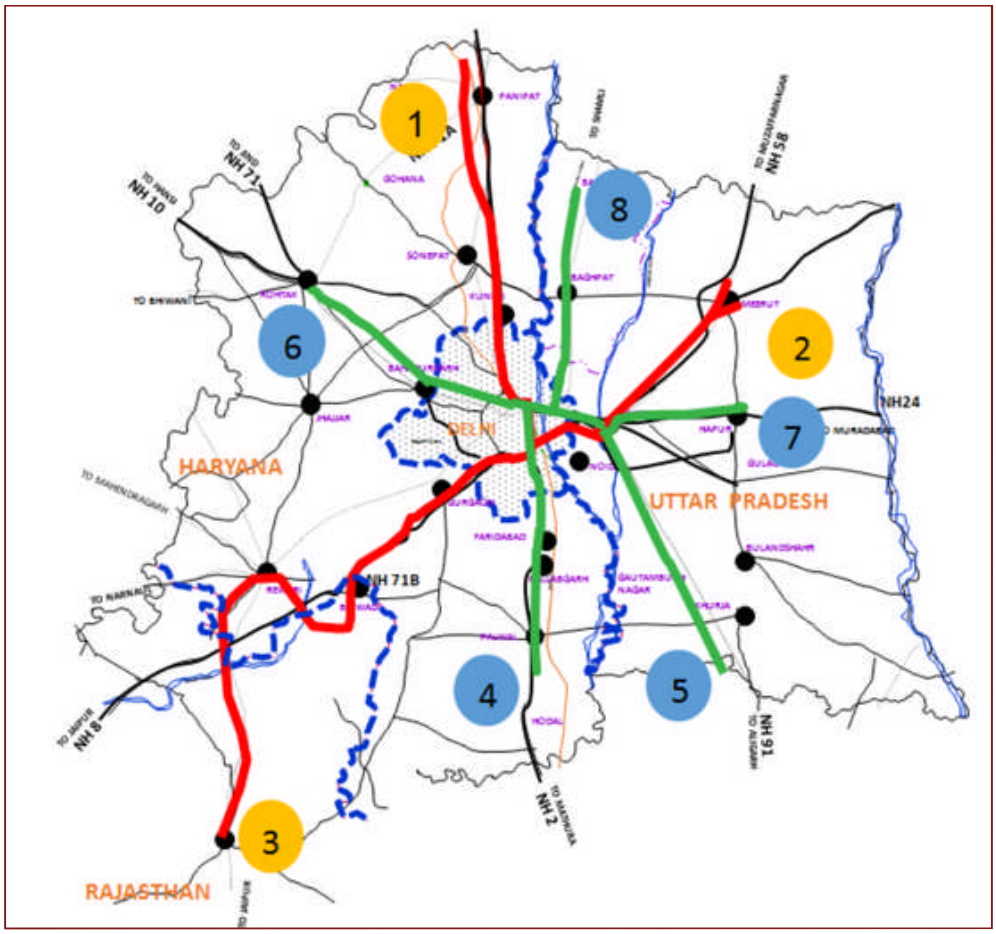
- **Connectivity enhancement from Noida:** At present, Jewar Airport site enjoys excellent road connectivity with the city of Noida. In addition to this, connecting Noida to the airport using metro railway will require extension of the metro railway line currently under construction till Greater Noida. A 39 km long metro railway line is under planning to connect Greater Noida to Jewar Airport. DMRCDC is being engaged in conducting the feasibility study of the proposed alignment.

4.5.2. Connectivity to enable spillover from Delhi

As IGI Airport reaches its capacity, the traffic may look for an alternative airport facility. As discussed, the traffic at IGI airport is largely driven by NCT of Delhi. In order to attract this spill-over traffic to the proposed airport at Jewar, it is advisable to enhance connectivity of the airport with areas in Delhi such that the total door-to-door time taken by the passenger from/to Jewar Airport is within one and half hour.

It is recommended to leverage the existing transport infrastructure plans to enhance the connectivity to the proposed airport. One of the key connectivity plans that may be considered by the government(s) is the integrated commuter railway network that is planned to effectively connect the National Capital Region and Delhi. As part of the plan, eight corridors have been identified to be linked by Rapid Rail Transit system. Out of eight corridors, three corridors have been prioritized: (1) Delhi-Soipat- Panipat (111 km); (2) Delhi-Ghaziabad-Meerut (90 km); and (3) Delhi-Gurgaon- Rewari-Alwar (180 km). These corridors are expected to have a common terminus station at Sarai Kale Khan which will provide inter-operability among three corridors.

Figure 44: Routes planned by NCRTC



The planned Rapid Rail Transit system is a high speed transport system which is aimed to cater passengers looking to travel relatively longer distances with fewer stops and at higher speed. This transport system is approximately three times faster than a normal metro and cover distances in one-third of the time of a normal metro (Table 5). Hence it is preferable for passenger traveling to/from the airport.

Table 5: Comparison between RRTS & normal metro

Transport system type	Design speed (km/ hour)	Operational speed (km/hour)	Average speed (km/ hour)	Time to travel 100 km (hour)
RRTS	180	160	100-150	1
Metro	90	80	32	3

Source: Primary and secondary research

To implement the connectivity project, Govt. of India and the participating states of Uttar Pradesh, Haryana, Rajasthan, and the NCT of Delhi formed a joint public sector company-National Capital Region Transport Corporation (NCRTC).

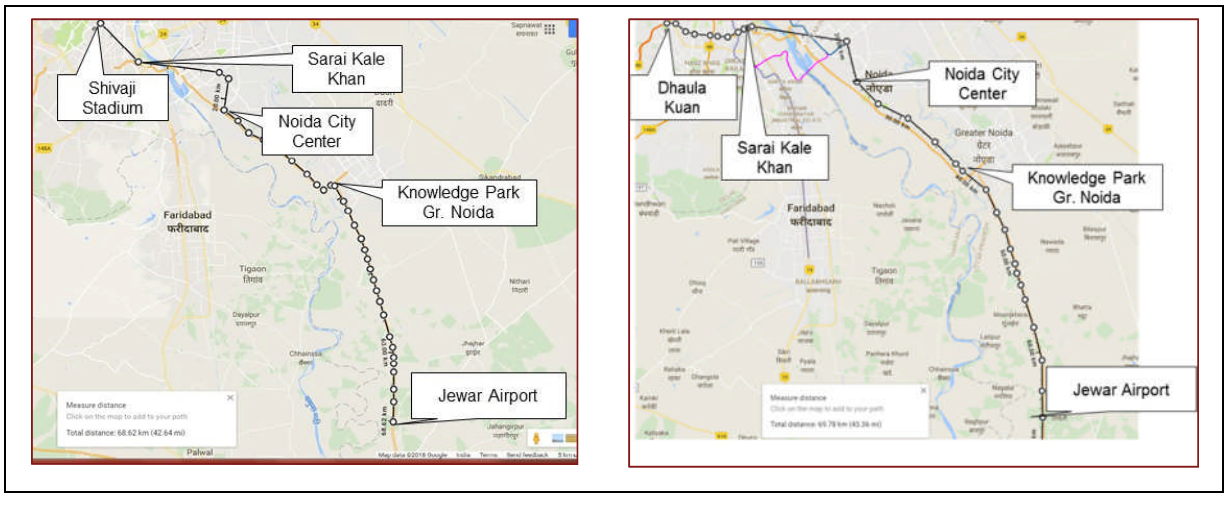
As one of the options, for connectivity between NCT of Delhi and Jewar, Sarai Kale Khan as a common center for connectivity may be looked at. Under this option, two alternative may explored:

- Alternative 1: Shivaji Stadium to Sarai Kale Khan to Noida City Center to Greater Noida to Jewar Airport.
  The distance of about 6 km between Sarai Kale Khan and Shivaji Stadium may be connected via an underground RRTS whereas connectivity from Sarai Kale Khan to Noida to Greater Noida and to Jewar airport may be done via an elevated RRTS.
  The total corridor length is estimated to be about 65-69kms which may result in travel time of about 40-45 minutes from central Delhi to Jewar airport.

- Alternative 2: Dhaulakuan to Sarai Kale Khan to Noida to Greater Noida to Jewar Airport. In the third phase of development of Delhi metro, Dhaulakuan would be a hub with connectivity planned from Punjabi Bagh, Shaimar Bagh, and Azadpur. Given the planned common terminus station at Dhaulakuan, an underground RRTS line may be considered between Dhaulakuan and Sarai Kale Khan. Beyond this point, Sarai Kale Khan, Noida, Greater Noida, and Jewar Airport may be connected via an elevated RRTS.

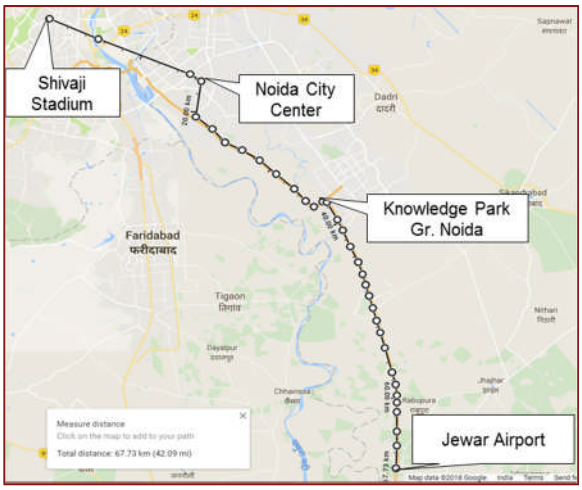
  The total corridor length is estimated to be about 60-62 km. This may result in travel time of about 40-45 minutes from Delhi to Jewar airport.

Figure 45: Options for RRTS routes (1 and 2)



- Alternative 3: Shivaji Stadium to Noida to Greater Noida to Jewar Airport: Other than the connectivity via Sarai Kale Khan, a direct connectivity from Shivaji Stadium to Noida to Greater Noida to Jewar airport may be considered. The total length of the corridor is around 69kms. It will connect central part of Delhi to the proposed airport and bring down the travel cost to about 40-45 minutes.

Figure 46: Connectivity option (3)



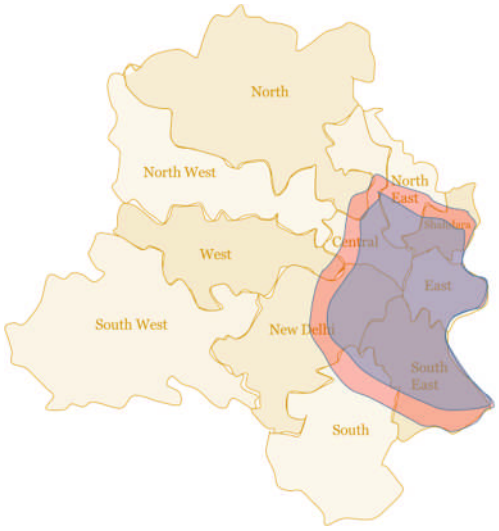
The cost of development of these routes is dependent on the final alignment of the RRTS. These estimates are based on broad cost benchmarks such as 350 crore INR per km for underground RRTS and 150 crore INR per km for overhead RRTS. These estimates reveal that the cost of development of these routes would be around 14,000 crore INR.

In addition to the RRTS option, Government may also consider a direct connectivity between IGI Airport and proposed airport at Jewar. A detailed study may be required to be undertaken to evaluate the potential connectivity options. It may be rapid rail, underground metro, highways, hyper-loop or other options.

The connectivity plan would have a direct impact on the potential traffic that can move from NCT to Jewar airport. The air traffic demand generated at different districts of NCT is expected to be closely related to the nature of work profile of the residents of those particular regions. Regions with higher work force in service industry such as finance, communication, trade and commerce etc. are more likely to generate air travel demand. Therefore, based on the census data on work profile of the residents, the likely demand for air travel is assessed.

As highlighted in the table below, air travel demand is fairly equally distributed amongst the different districts of NCT. The demand is however fairly low in central part of Delhi. This is in-line with the expectation as significant proportion of population of NCT resides in periphery of the city rather than in central Delhi.

Figure 47: Distribution of air traffic across different districts of NCT of Delhi



Districts of NCT	Percentage of overall air travel demand from NCT
North West	18%
North	5%
North East	9%
East	11%
New Delhi	3%
Central	4%
West	15%
South West	17%
South/South East	18%

Given the traffic distribution, airport at Jewar would be able to attract traffic depending upon the connectivity it gets from different regions of NCT. In the base case of the TEFR, even post the spill-over of traffic from IGI, only about 30% of NCT traffic is susceptible to move to the new airport at Jewar. This would cover regions like East of Delhi, South East of Delhi and certain proportion of Central and New Delhi. This region is earmarked based on the districts that are likely to reach airport at Jewar in about an hour and a half. Potential to attract traffic may further increase with investment in connectivity. NCRTC and DMICDC are currently undertaking detailed connectivity study for the proposed airport.

4.6. Regional connectivity scheme

4.6.1. About the scheme

The National Civil Aviation Policy 2016 sets an ambitious target of achieving an annual domestic ticketing target of 350 million by 2022 and 500 million by 2027 compared to 70 million during 2014-15[7].

In order to spur growth in the domestic market, the Policy places significant focus on smaller cities and their growing middle class population. With the intention of making flying more accessible and affordable to people in the smaller cities, the Policy has come up with the Regional Connectivity Scheme (RCS).

Fiscal support and infrastructure development are the twin pillars on which the RCS is based. Some of the key features of the scheme are as under:

- ***RCS Seats and Viability Gap Funding:*** This scheme provides for a viability gap funding for a certain percentage of seats in an aircraft operating on a route listed under the scheme. [8] The Policy mentions an upper ceiling of 2500 INR (for a flight of 1 hour duration) that may be charged for a ticket for a seat under the RCS. The loss the airline may have to bear owning to the price ceiling shall be compensated using the fund for viability gap funding.[9] For the remaining seats within the same aircraft, the airline operator is free to set the fare.

- ***Tax and Financial Incentives:*** A number of benefits have been offered for the participants of the scheme. The benefactors are the Govt. of India, the governments at the states, and the airport sector operators and regulators. Some of the incentives under this scheme include concessions on VAT on purchase of aviation turbine fuel, concessions on service tax, excise duty on purchase of ATF, and concessions on airport services.[10]

- ***Airports:*** The scheme places emphasis on the need to develop currently unused or underused airports and airstrips. The Policy states that airports under RCS may be developed at a cost of 500-1000 million INR without insisting on its financial viability.

[7] The Government has proposed to take flying to the masses by making it affordable and convenient. For example, if every Indian in middle class income bracket takes just one flight in a year, it would result in a sale of 35 crore tickets, a big jump from 7 crore domestic tickets sold in 2014-15. This will be possible if the air-fares, especially on the regional routes, are brought down to an affordable level. *(Extract from the policy document)*
[8] The minimum number of seats in an aircraft under RCS shall be 9 (if capacity is less than 9, all seats will be RCS seats). For larger aircrafts the number of RCS seats shall be 50% of the total seat capacity or a total of 40 seats, whichever less.
[9] The process of claiming subsidy is based on competitive bidding.
[10] Now post introduction of GST, the applicable GST rates would apply.

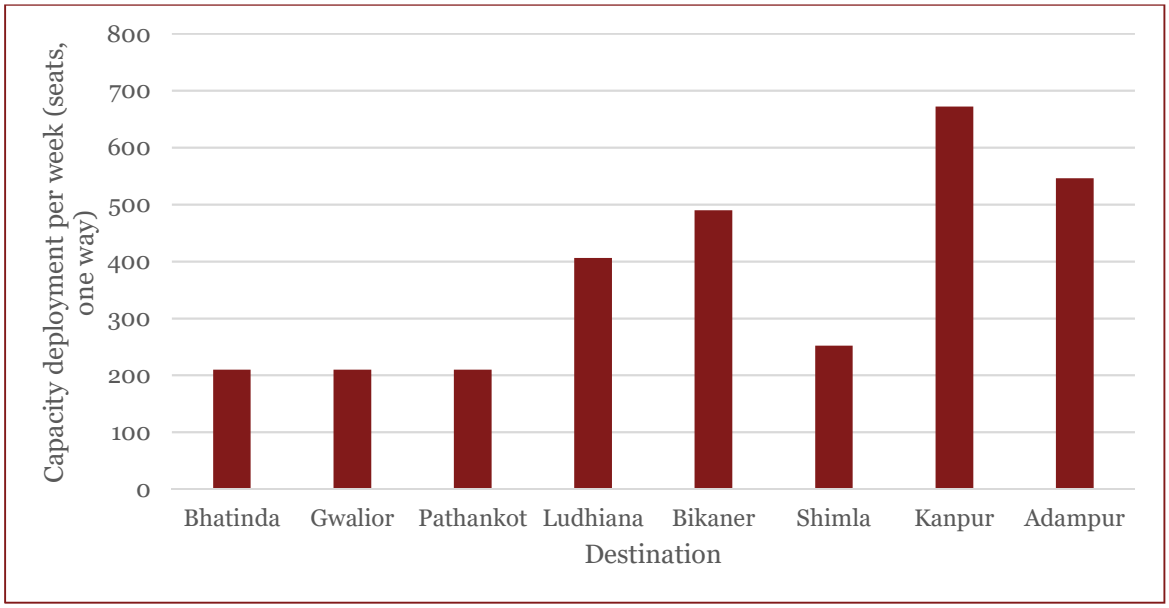
It is worth noting that a number of airlines have opted for the benefits offered under this scheme. For example, in March 2017, the Government of India awarded 128 regional routes (covering 45 airports) to five airlines — Alliance Air, SpiceJet, Turbo Megha, Air Odisha, and Air Deccan.[11]

4.6.2. Impact of RCS on traffic at Jewar

As part of the Phase I of route allocation under RCS, eight cities are awarded to be connected to Delhi. The eight cities include: Bhatinda, Gwalior, Pathankot, Ludhiana, Bikaner, Shimla, Kanpur and Adampur (Jalandhar)

Figure 48 depicts the capacity deployment along the routes under RCS (as per Phase I of RCS). It may be observed that Kanpur and Bikaner have seen the largest capacity deployment. Additional routes to places like Kargil, and Pakyong have been awarded under Phase II of RCS.

Figure 48: Capacity deployment under RCS (Phase I) destinations for Delhi, weekly one way (total seats)

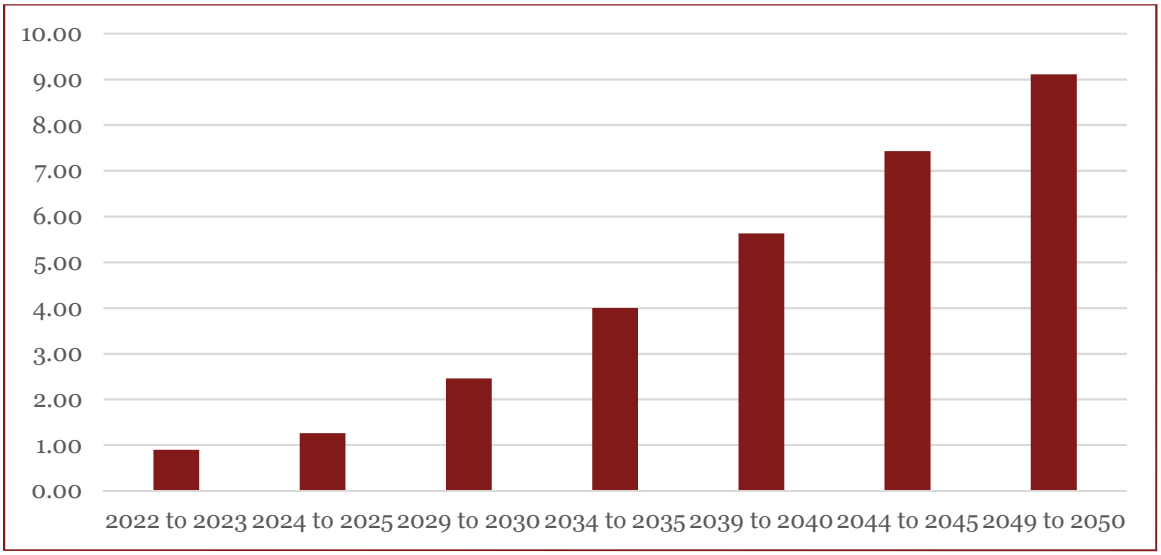


Source: AAI

In addition to the current deployment, the future RCS demand will get impacted by two factors: a) natural growth in air travel demand due to economic progress and b) modal shift from railways to air. The interplay of these two factors will provide the quantum of RCS traffic. Based on analysis carried out along such lines. Figure 49 depicts the potential RCS generated traffic that may be handled by airports in Delhi NCR.

[11] The Hindu Business Line, 30th of March 2017.

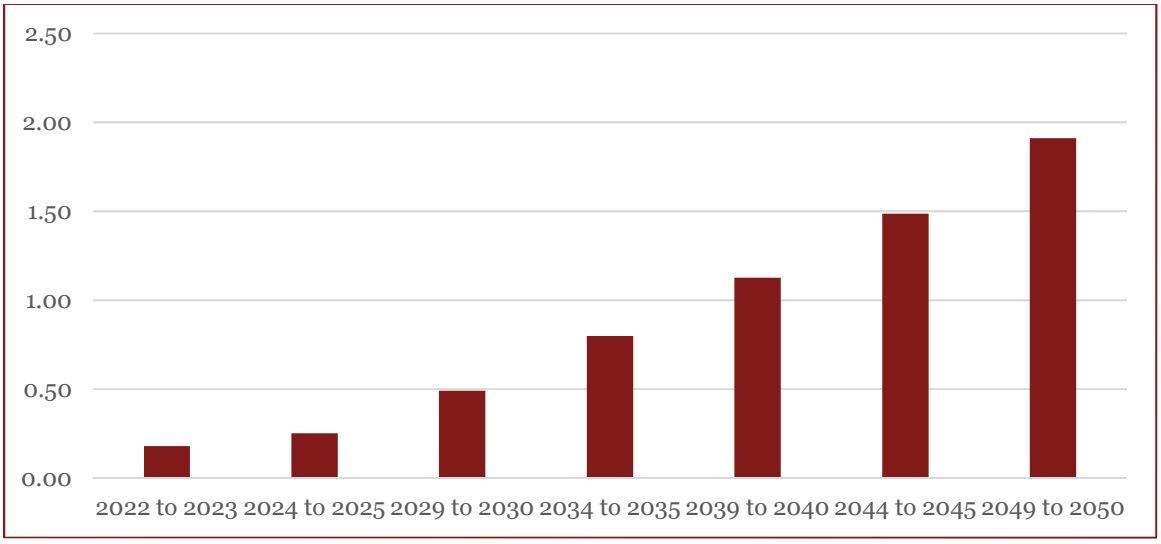
Figure 49: RCS based traffic potential in NCR region



Source: PwC analysis

In order to cater to the demand of the NCR region, Government is planning to develop airbase in Hindon (Ghaziabad) for handling RCS traffic. Hindon is strategically located to serve NCT of Delhi and its satellite cities. In addition to Hindon, there are other airports such as Meerut, Agra that can be used for the operations of RCS flights. Given the network of smaller airports around Jewar, the proposed airport at Jewar is expected to carter to only about 20-25 percent of the total RCS demand. Figure 50 highlights the total RCS potential for the proposed airport at Jewar.

Figure 50: RCS based traffic potential at Jewar Airport

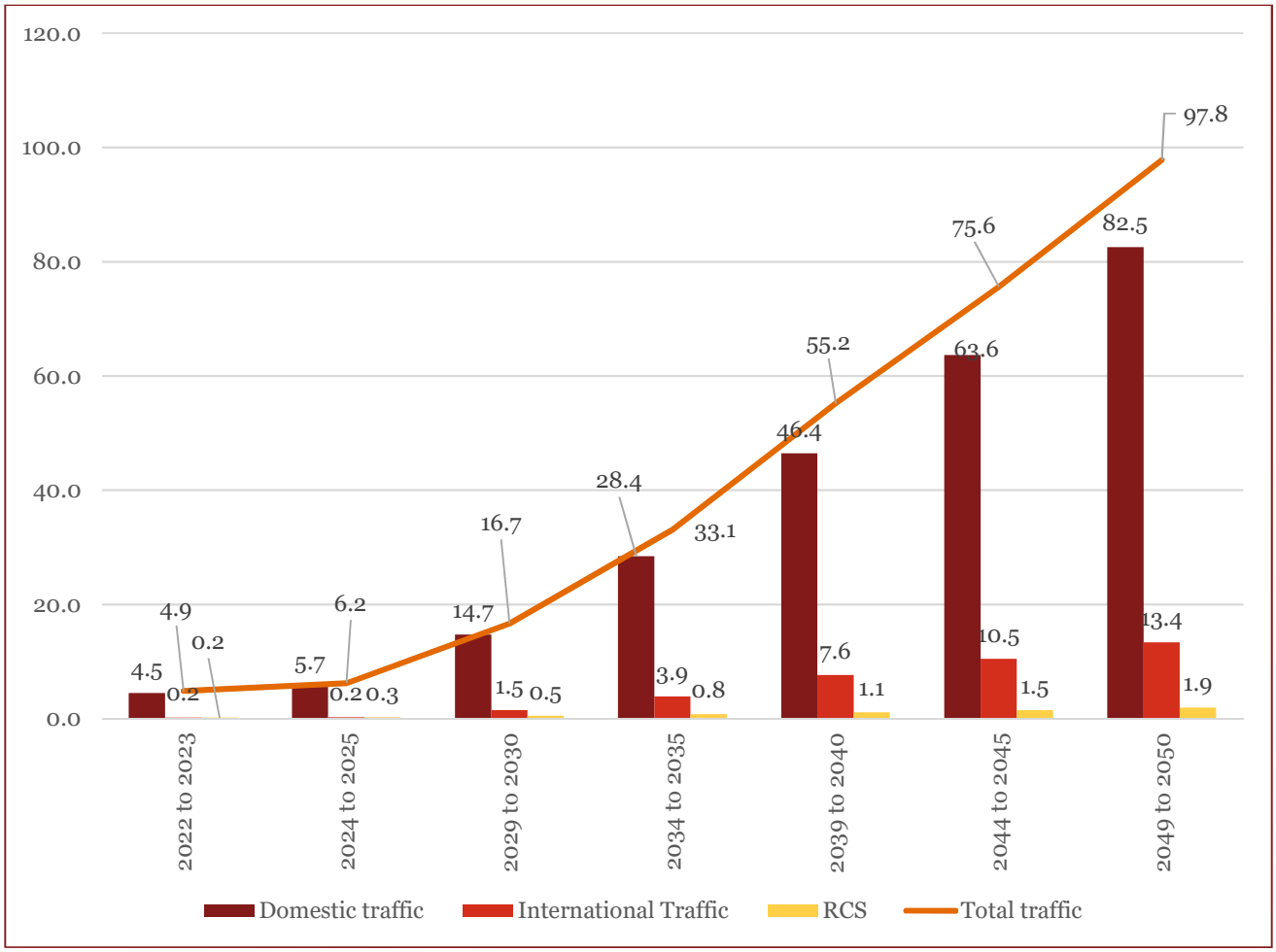


Source: PwC Analysis

4.7. Total Traffic Estimates

At the start of operations in the year 2022-23, Airport at Jewar may serve a total annual passenger demand of around 5 million. By 2029-30 the annual passenger handling is expected to go up to ~ 16 million, reporting a growth rate of about 19 percent. The growth would be observed both in domestic and international passenger at around 18 percent and 33 respectively. By 2050, the airport traffic demand at the airport may reach to about 98 million passengers annually. However, given the current master plan, airport may cater to about 70-77 million passengers annually.

Figure 51: Final demand for traffic at Jewar Airport



Source: PwC analysis

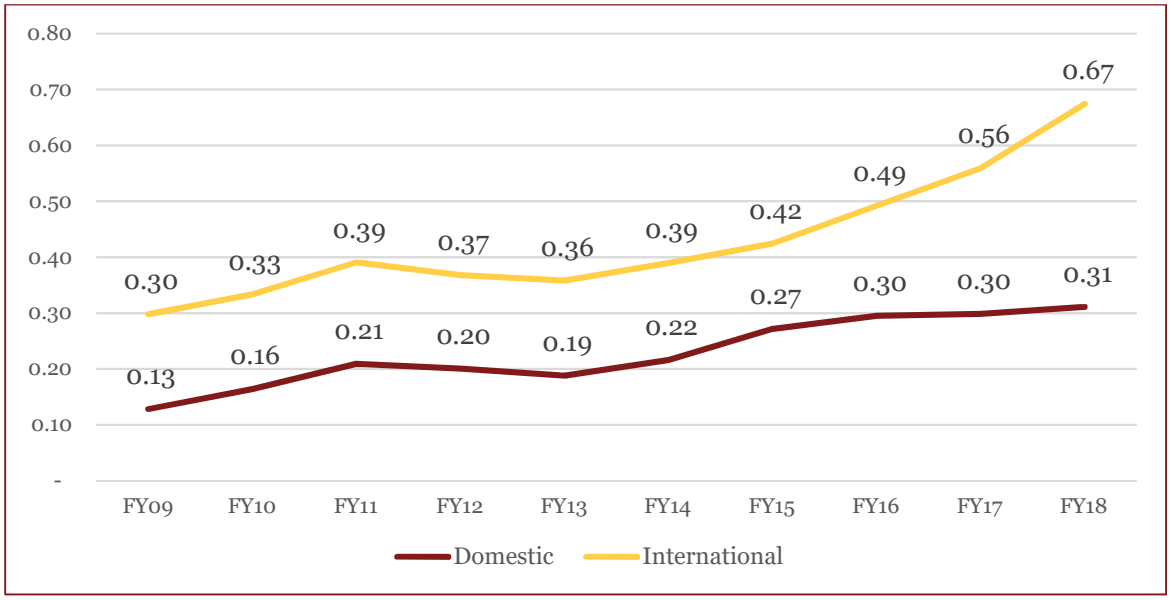
5. Cargo potential

This section provides a detailed view on the cargo potential at the proposed Jewar Airport. Before discussing the potential, the section also provides a brief overview cargo traffic at IGI Airport as the proposed airport at Jewar is likely to cater the hinterland which is currently being serviced by IGI Airport.

5.1. Cargo traffic at IGI Airport

The cargo traffic at IGI Airport stands at 0.9 million (FY17) which is growing at a CAGR of 8.6% in the last 5 years. The total volume is expected to reach 1 million tons in FY18. Out of total cargo handled at IGIA, 30% of the cargo is domestic and remaining 70% is international cargo movement. Both the cargo categories have experienced a healthy growth rate in the last few years.

Figure 52: Historical cargo at IGI Airport (million tons)

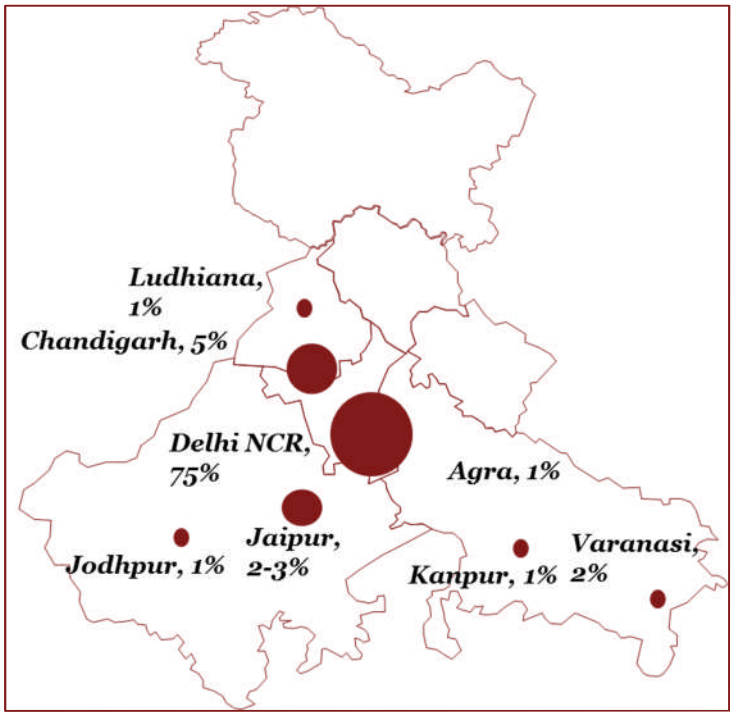


Source: DGCA

The international cargo has grown from 0.4 million tons in FY14 to 0.7 million tons in FY18 – a CAGR of 15%. The growth rate has been higher than that of all India growth rate, which is ~9% CAGR. IGI Airport caters to nearly 30% of the international cargo from India, thus acting as a gateway airport. While there are international airports in North India (Jaipur, Amritsar, Varanasi, Chandigarh), they have limited air connectivity vis-à-vis IGI Airport. Due to higher connectivity, hinterland for IGI Airport not only includes Delhi NCR but also includes UP, Rajasthan, Punjab and other North Indian states. The following figure shows the hinterland for international cargo at IGI. Nearly 75% of the cargo

comes from Delhi NCR region. Other prominent cargo generators include Ludhiana (textiles), Jaipur (gems), Jodhpur, Kanpur (leather), Varanasi (carpets), and Chandigarh etc.

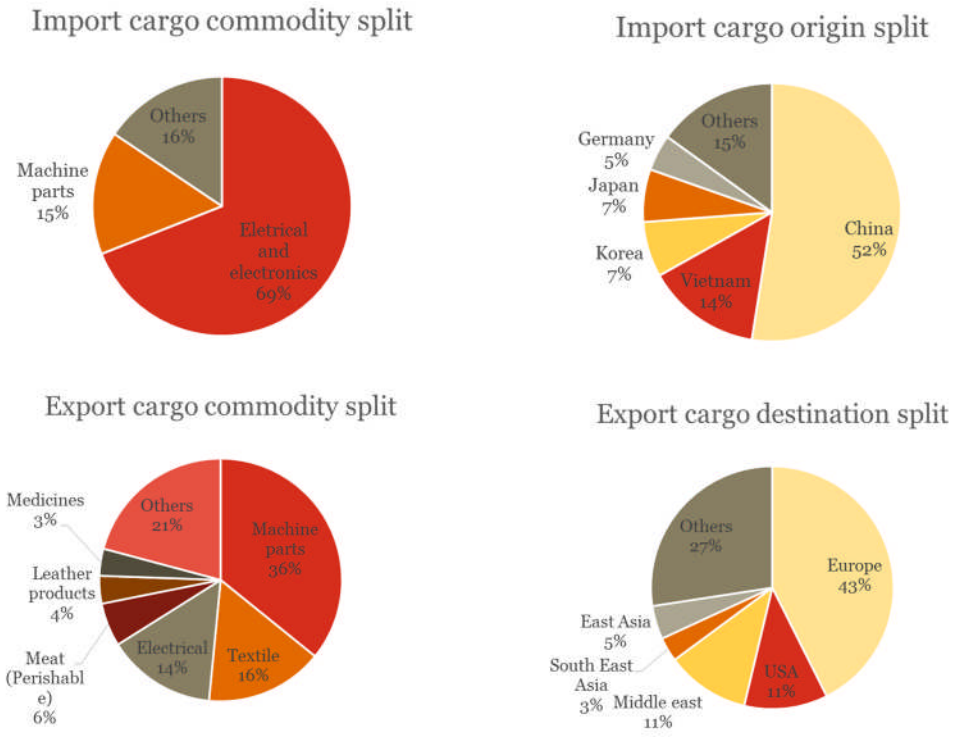
Figure 53: IGI airport hinterland



Source: PwC analysis

Export cargo accounts for nearly 35% of the international cargo at IGI airport. Electronics is one of the key commodities being exported from IGI airport followed by machinery parts, perishable etc. Europe accounts for nearly ~40% of the export cargo destination, followed by USA and Middle East. In terms of imports, electrical and machinery are the major import commodities at IGI airport. Most of imports are from China (~50%) followed by Vietnam (14%) and Korea (7%).

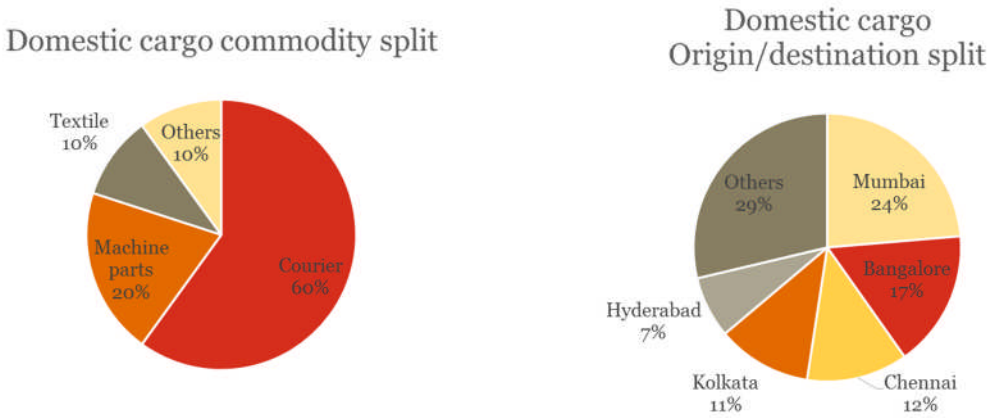
Figure 54: Cargo movement at IGI



Source: PwC analysis

Like international cargo, domestic cargo has also observed robust growth in the last few years. Domestic cargo at IGI airport has grown from 0.2 million tons in FY14 to 0.3 million tons in FY18 – a growth of 10% CAGR. Courier accounts for nearly 60% of the domestic cargo. Other key commodities include machinery parts and textiles. The hinterland for domestic cargo primarily includes the Delhi NCR.

Figure 55: Domestic cargo details



Source: PwC analysis

5.2. Cargo potential at Jewar

The approach for estimating cargo potential at Jewar is divided into three broad modules. In the first module, overall hinterland demand has been estimated using various projection models (multi-variable linear and logarithmic regression models). The estimation includes projection for the entire hinterland that can be catered by IGI airport and the proposed airport at Jewar.

In the second module, the cargo generated in the entire hinterland is divided between proposed Jewar airport and IGI airport. Distance between the airport and the cargo generating centers is expected to be a key factor influencing cargo movement. For instance, cargo generated in Greater Noida region is more likely to move to the airport at Jewar than to IGI airport. Whereas cargo originating from Manesar region (Gurgaon District) is more likely to move to IGI than compared to the airport at Jewar. Based on the proximity of the cargo generating center and the airport, the cargo traffic is likely to split.

These estimate however would only provide demand side perspective. The actual cargo handling at an airport is dependent not only on the proximity of the airport to the cargo generating center but also on the air connectivity that the airport can provide. In addition, apart from connectivity, the cargo holding capacity of aircrafts would also have a direct impact on the cargo movement to the proposed Jewar airport. These supply side factors of connectivity and capacity are analyzed in detail in the third module.

5.3. Overall hinterland demand

Linear regression and logarithmic models are used to estimate the overall hinterland demand. Literature on cargo demand estimate highlights strong correlation of air cargo movement with GDP and crude oil prices. Hence factors such as India's GDP, World GDP and crude oil prices are considered for projecting future cargo traffic.

The traffic estimates based on the regression estimates map the actual traffic movement (Figure 94 and Figure 95). This further validates the precision with which the cargo traffic can be forecasted for the future based on the independent factors such as GDP and crude oil prices.

Based on the regression analysis (Appendix C. -), the projected cargo traffic for the hinterland is expected to reach 2.5 million tons by FY26 and 3.6 million tons by FY31. The growth rate for international cargo is expected to be 12-13% for the next 10 years while the growth rate for domestic cargo is expected to be 8 – 9 %.

Table 6: Cargo forecast for hinterland

Year	Domestic cargo ('000 tons)	International cargo ('000 tons)
2017 - 2018	311	675
2018 - 2019	337	769
2019 - 2020	366	879
2020 - 2021	399	992
2021 - 2022	436	1,140
2022 - 2023	474	1,305
2023 - 2024	514	1,487
2024 - 2025	555	1,676
2025 - 2026	598	1,871
2026 - 2027	641	2,068
2027 - 2028	686	2,264
2028 - 2029	731	2,457
2029 - 2030	776	2,643
2030 - 2031	822	2,820
2031 - 2032	867	2,986
2032 - 2033	914	3,142
2033 - 2034	963	3,303
2034 - 2035	1,014	3,469
2035 - 2036	1,066	3,640
2036 - 2037	1,119	3,816
2037 - 2038	1,175	3,997
2038 - 2039	1,231	4,183
2039 - 2040	1,289	4,373
2040 - 2041	1,348	4,568
2041 - 2042	1,409	4,768
2042 - 2043	1,472	4,973
2043 - 2044	1,536	5,183
2044 - 2045	1,601	5,397

Year	Domestic cargo ('000 tons)	International cargo ('000 tons)
2045 - 2046	1,668	5,617
2046 - 2047	1,736	5,842
2047 - 2048	1,806	6,071
2048 - 2049	1,878	6,306

Source: PwC analysis

Table 7: Historical cargo growth rate

Year	International cargo growth	Domestic cargo growth
2013 – 2017	15%	10%
2017 – 2021	14%	9%
2021 – 2025	13%	8%
2025 - 2030	9%	7%
2030 – 2040	5%	5%

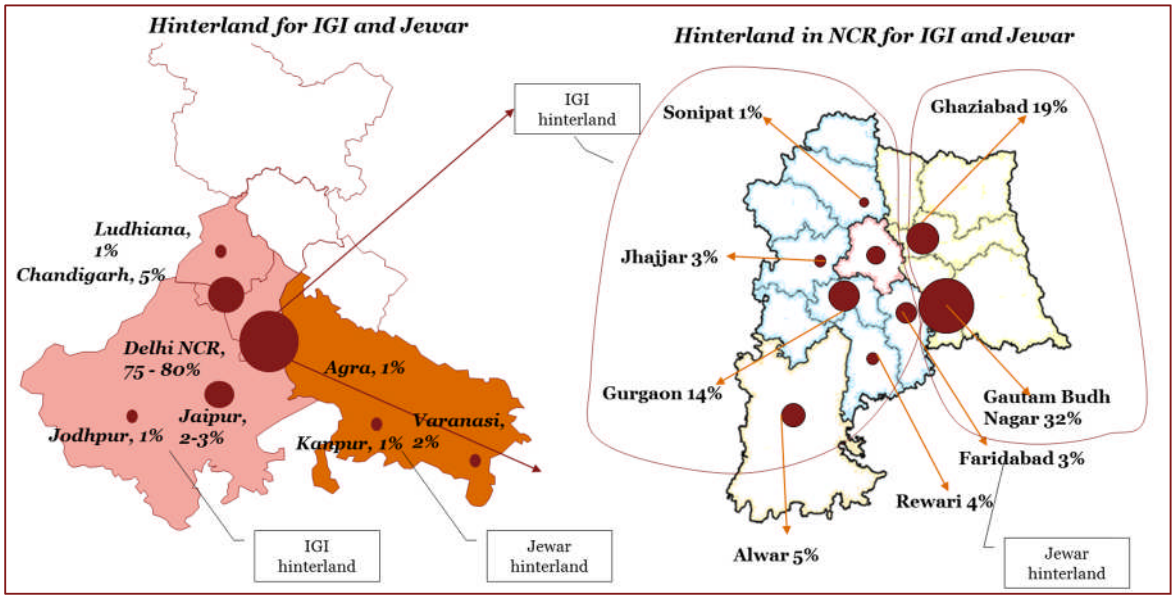
Source: PwC analysis

5.4. Cargo demand at Jewar

The estimates in the previous section provides cargo movement for the entire hinterland of IGI airport and the proposed airport at Jewar. With starting of the operations of the new airport at Jewar, the cargo traffic demand is expected to split in the future. The split is primarily expected to be based on the distance between the airport and the cargo generating center. In addition to distance, improvement of road connectivity is also expected to divert traffic from IGI airport to the new airport.

Figure below shows the hinterland division between IGI and Jewar superimposed with the cargo origin centers. In NCR region, Gautam Budh Nagar and Ghaziabad are the 2 major cargo generating centers which are part of Jewar's hinterland. Estimates reveal that about 50% of the NCR international cargo at IGI airport is generated in these two districts. Other districts such as Gurgaon, Jhajjar, and Faridabad which are part of IGI hinterland in NCR region contribute ~30% of the international cargo.

Figure 56: Hinterland for Jewar airport

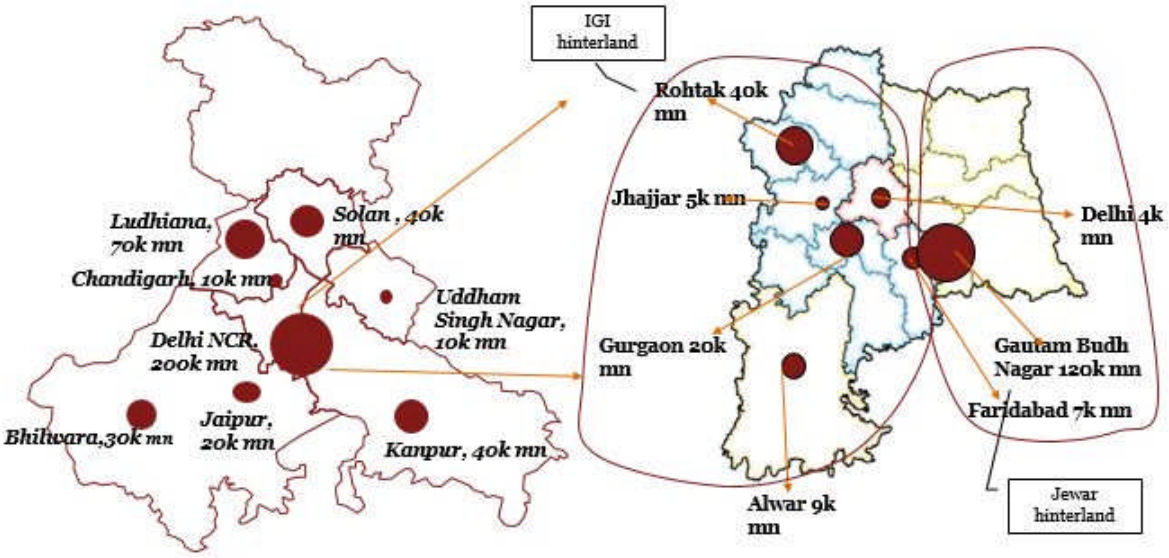


Source: PwC analysis

In addition to the current traffic movement, potential investments in air cargo centric industries such as electronics, machine parts, pharmaceuticals, leather etc. would also play a key determining role in determining future cargo movement. Figure below shows the potential investments that may be realized by the next 4-5 years.

As per the investment plans, a total of 2, 00,000 million INR of investment is expected to be realized in the Delhi NCR region. Gautam Budh Nagar is expected to account nearly 1,20,000 million INR of investments, which is primarily in the electronics sector. Some of the key investments include Samsung Mobile Phone plant expansion (50,000 million INR), Lava mobile phone plant (6000 million INR), Intex mobile phone plant (15,000 million INR) etc. A detailed list of investments in the region has been given in the appendix.

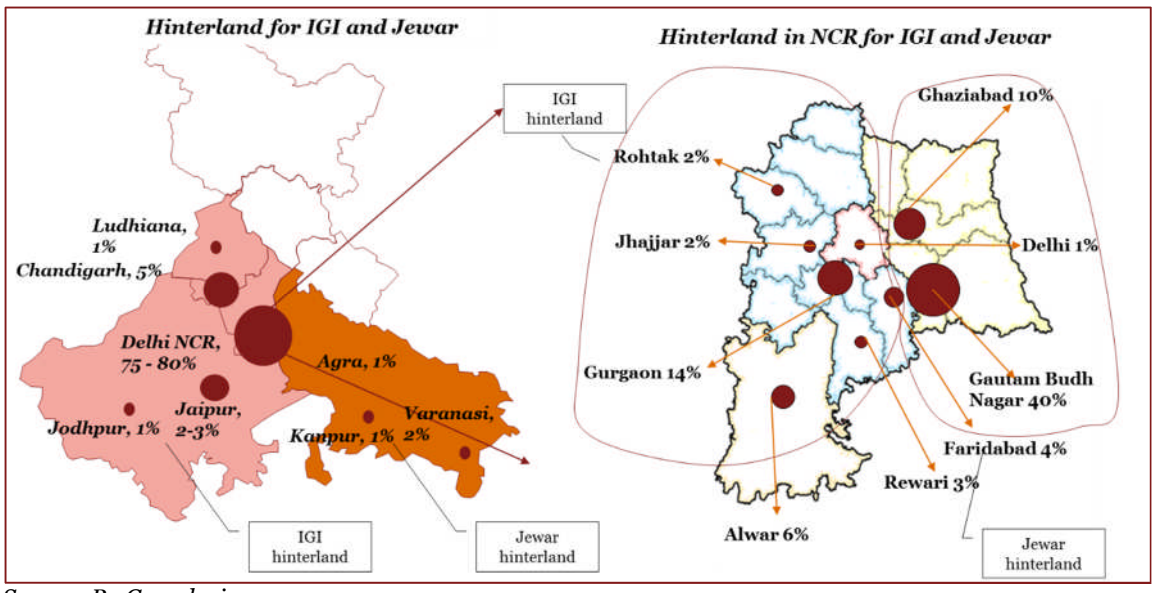
Figure 57: Future investments in the region



Source: PwC analysis

The investment in the Jewar hinterland is expected to drive up the cargo for Jewar. Based on existing investment and future investments, the share of cargo for each district is highlighted in the figure below. It shows that out of the total cargo traffic in the hinterland, Gautam Budh Nagar may account for 40% of the traffic in future, up from 35% currently. Overall, proposed airport at Jewar may be in a position to cater to nearly 55% of the total cargo[12].

Figure 58: International cargo origin centers in future

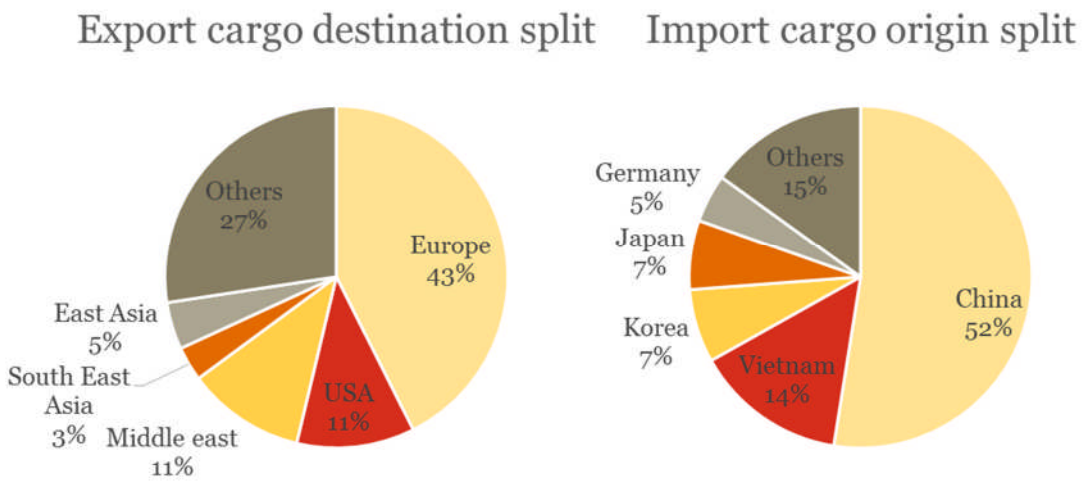


Source: PwC analysis

[12] See annexure for IGI capacity

Realization of the actual cargo volume would be dependent not only on the proximity of the airport to the cargo generating center but also on the air connectivity that the airport can provide. Figure 59 shows the current cargo movement at IGI airport. As per the cargo data released by DGCIS, Europe accounts for nearly ~40% of the export cargo destination, followed by USA and Middle East. In terms of imports, electrical and machinery are the major import commodities at IGI airport. Most of imports are from China (~50%) followed by Vietnam (14%) and Korea (7%).

Figure 59: OD pair for international cargo



International cargo is carried both via dedicated freighters (50%) and via belly cargo (50%). While freighters may be deployed depending on the cargo potential of a region, passenger aircrafts are typically deployed based on the passenger demand of the region. This implies that belly cargo at Jewar may depend on the passenger destinations realized.

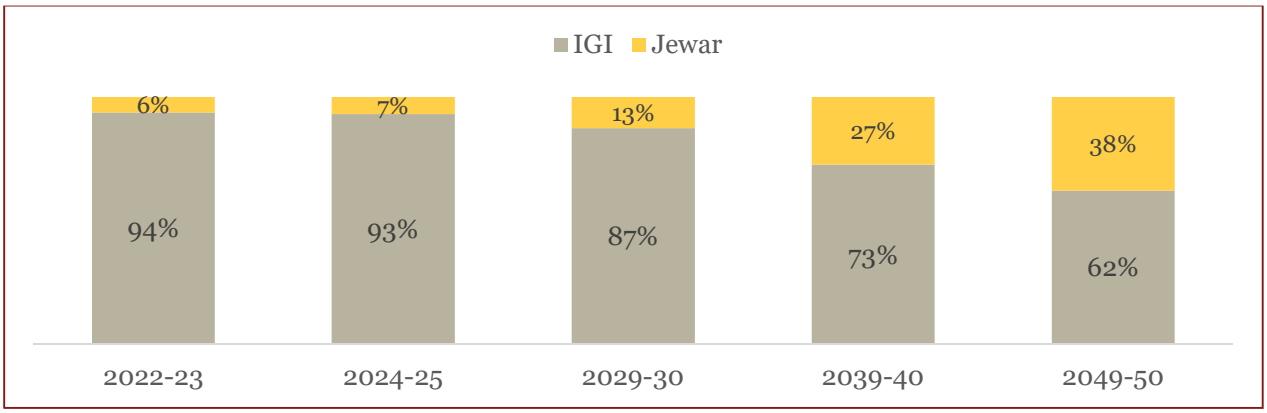
As discussed in the passenger analysis section, by 2022-23, Jewar Airport may serve only one international destinations. This implies that destinations such as China and Vietnam, which occupy significant share of the cargo, will not be realized in the initial years. Belly cargo for such destinations may be catered by IGI airport. However, as more destinations are added to Jewar, the cargo traffic for may shift to Jewar airport.

Apart from connectivity, belly holding capacity of the aircraft would also have a direct bearing on the cargo movement at the airport. In international flights, typically Code C or Code E/F aircrafts are deployed. While a Code C aircraft has a belly hold capacity of 2 MT, a Code E aircraft may accommodate cargo up to 15 MT. Fleet mix and ATM movement along various international routes are analysed in order to at the total cargo holding capacity at each route.

Therefore, though 50 percent of international cargo movement, is expected to be catered by freighter, the rest 50 percent would be dependent on the cargo holding capacity in the belly of the aircraft.

Similar trend may also be observed for domestic cargo movement as 80% of the domestic cargo is airlifted in the belly of an aircraft. This implies that the passenger aircrafts govern the movement of air cargo on the domestic sector. As discussed in the previous section, in 2021-22, Jewar may cater to ~6% of the domestic ATM traffic, which will go up to 7% in 2024-25 and 38% by 2049-50. This ATM traffic split is expected to drive the domestic cargo split between IGI and Jewar airport.

Figure 60: Domestic ATM split between IGI and Jewar



Source: PwC analysis

Given the hinterland investment and connectivity, proposed airport at Jewar may cater to 6% of the domestic cargo traffic in the hinterland in 2022-23. This translates into ~32,000 tons of cargo in FY23. With increase in domestic connectivity at the airport, the domestic cargo is also expected to ramp up ~1,40,000tons by FY30.

Similarly, given 50 percent of the international cargo movement by freighter and rest in the belly of the aircraft, total international movement from Jewar may increase from 0.4 million metric tons in 2022-23 to about 2 million metric tons in 2048-49.

Table 8: Cargo traffic forecast for Jewar

Year	Domestic cargo ('000 MT)	International cargo ('000 MT)
2022 - 2023	32	388
2023 - 2024	39	441
2024 - 2025	47	497
2025 - 2026	60	561
2026 - 2027	72	620

Year	Domestic cargo ('000 MT)	International cargo ('000 MT)
2027 - 2028	82	679
2028 - 2029	104	750
2029 - 2030	121	807
2030 - 2031	138	863
2031 - 2032	156	919
2032 - 2033	174	967
2033 - 2034	204	1,019
2034 - 2035	221	1,087
2035 - 2036	258	1,146
2036 - 2037	296	1,205
2037 - 2038	327	1,262
2038 - 2039	357	1,328
2039 - 2040	388	1,391
2040 - 2041	420	1,460
2041 - 2042	457	1,523
2042 - 2043	493	1,588
2043 - 2044	530	1,656
2044 - 2045	569	1,735
2045 - 2046	609	1,827
2046 - 2047	652	1,898
2047 - 2048	698	1,972
2048 - 2049	750	2,052

Table 9: Cargo growth rates at Jewar

Period	International cargo growth	Domestic cargo growth
2021 – 2025	13%	23%
2025 – 2030	9%	18%
2030 – 2035	5%	13%
2035 – 2040	5%	10%

Source: PwC analysis

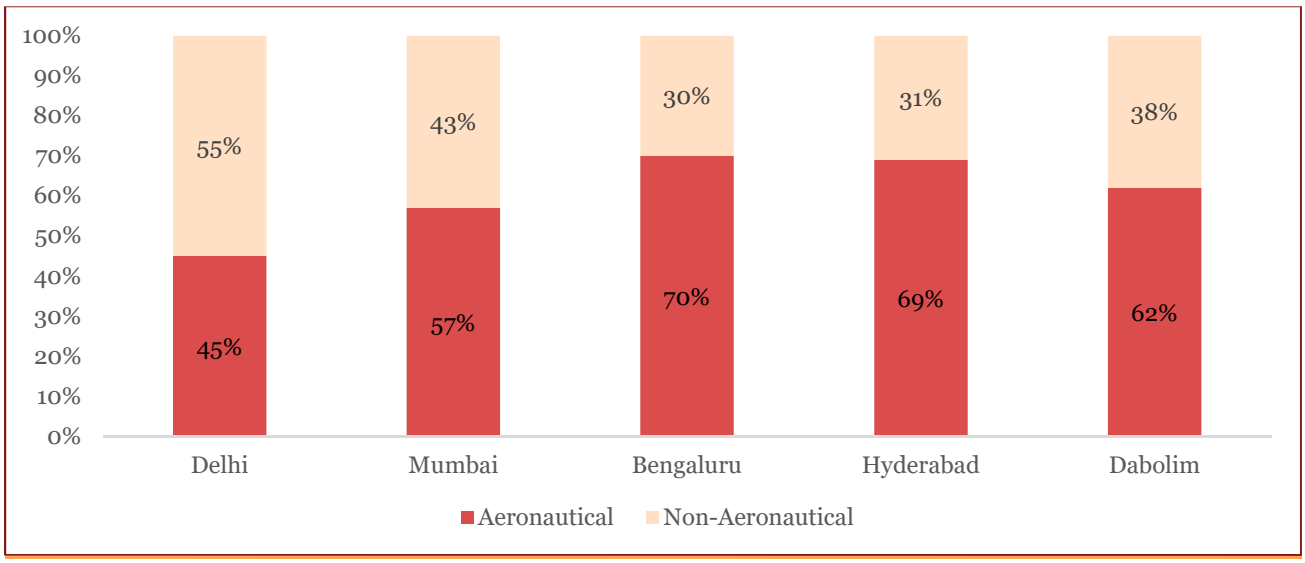
6. Non-aeronautical revenue

6.1. Importance of non-aeronautical revenue

Aeronautical charges are an integral revenue source for an airport operator but no longer the nucleus. Operators are increasingly trying to capitalize on non-aeronautical revenue potential of an airport. The key non-aeronautical sources include duty free sales, food and beverages, in-flight kitchen, retail etc.

Revenue of the airports are in-line with the above stated trend. As highlighted in Figure 61, at most Indian airports non-aeronautical revenue ranges between 30%-40% compared to international airports reporting around 40%-50% of their revenue from non-aeronautical sources.

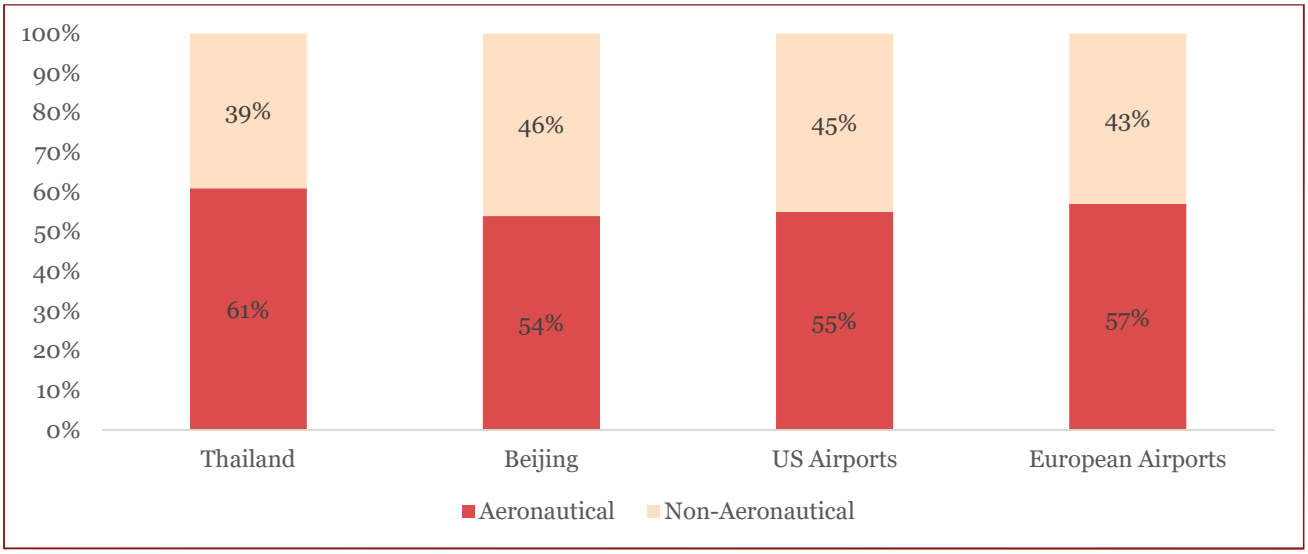
Figure 61: Share of aeronautical and non-aeronautical revenue at Indian airports



Source: Primary and secondary research, PwC analysis

For instance, non-aeronautical revenue forms approximately 46% of the total revenue generated at Beijing airport. Similarly, 45% of the total revenue at commercial airports in USA is derived from non-aeronautical activities like duty free, rental, retails, etc.

Figure 62: Share of aeronautical and non-aeronautical revenue at international airports



Source: Primary and secondary research, PwC analysis

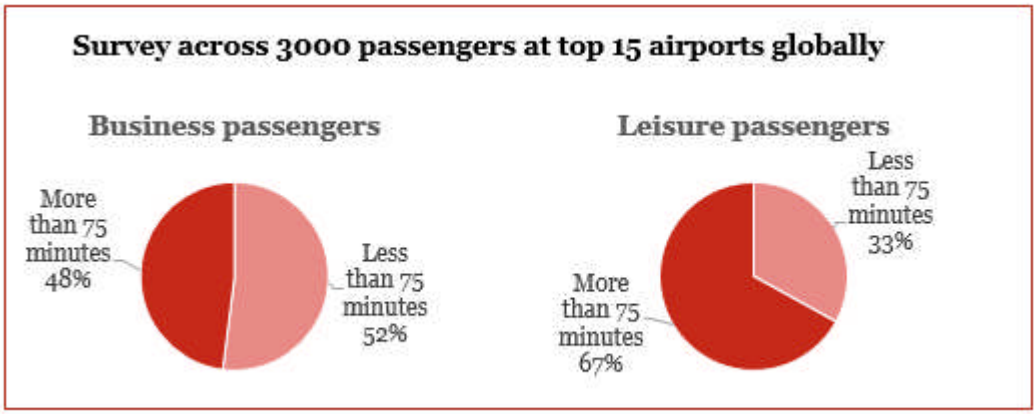
In order to moderate the cost of flying, airport operators are constant need to develop other revenue sources to ensure continued revenue growth to maintain or increase profitability.

6.2. Factors impacting non-aeronautical revenue potential

There are three main factors impacting the non-aeronautical revenue potential of an airport. First is the profile of the passenger. Passengers are usually profiled into two categories- business vs leisure passengers and domestic vs international passengers. It has been observed across various airports that leisure passengers typically contribute more to non-aeronautical revenue than business passengers. This is due to higher dwell time of leisure passengers' vis-à-vis business passengers'. As shown in the following figure[13], the average dwell time of a business passenger is compared with that of a leisure passenger. 67% of leisure passengers spend more than 75 minutes at the airport. In contrast, only 48% of business passengers spend more than 75 minutes. A higher dwell time gives the passenger more time to spend at the airport.

[13] Source: DKMA Airport Retail and F&B Survey; PASSENGER SATISFACTION THE KEY TO GROWING NON-AERONAUTICAL REVENUE

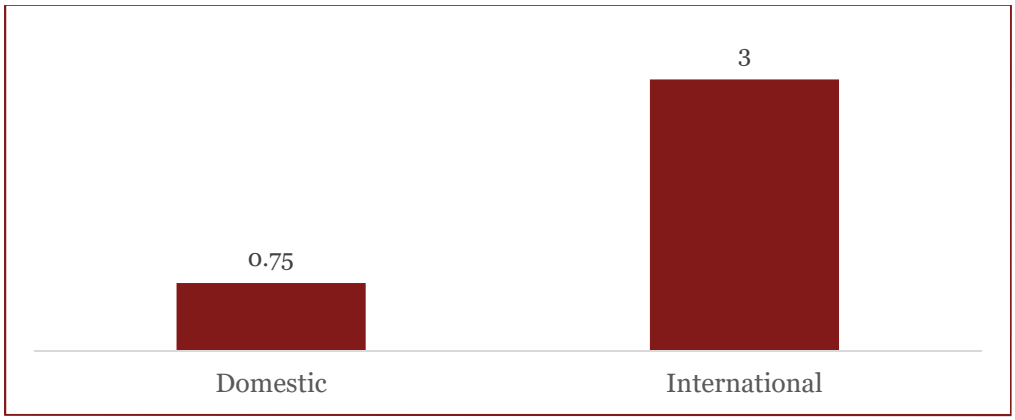
Figure 63: Dwell time at airports, by passenger type



Source: DKMA

In addition, it has been observed that there is a high correlation between non-aeronautical revenue and increase in international traffic. This may be because of the higher dwell time spent by an international passenger at the airport compared to a domestic passenger. As per DGCA norms, a domestic passenger is expected to check in 0.75 hours before flight time whereas an international passenger is expected to check in 3 hours prior. Higher dwell time gives more time at the airport that may result in higher non-aeronautical spend. Also many international passengers have a high per capita income indicating a higher potential for non-aeronautical spend.

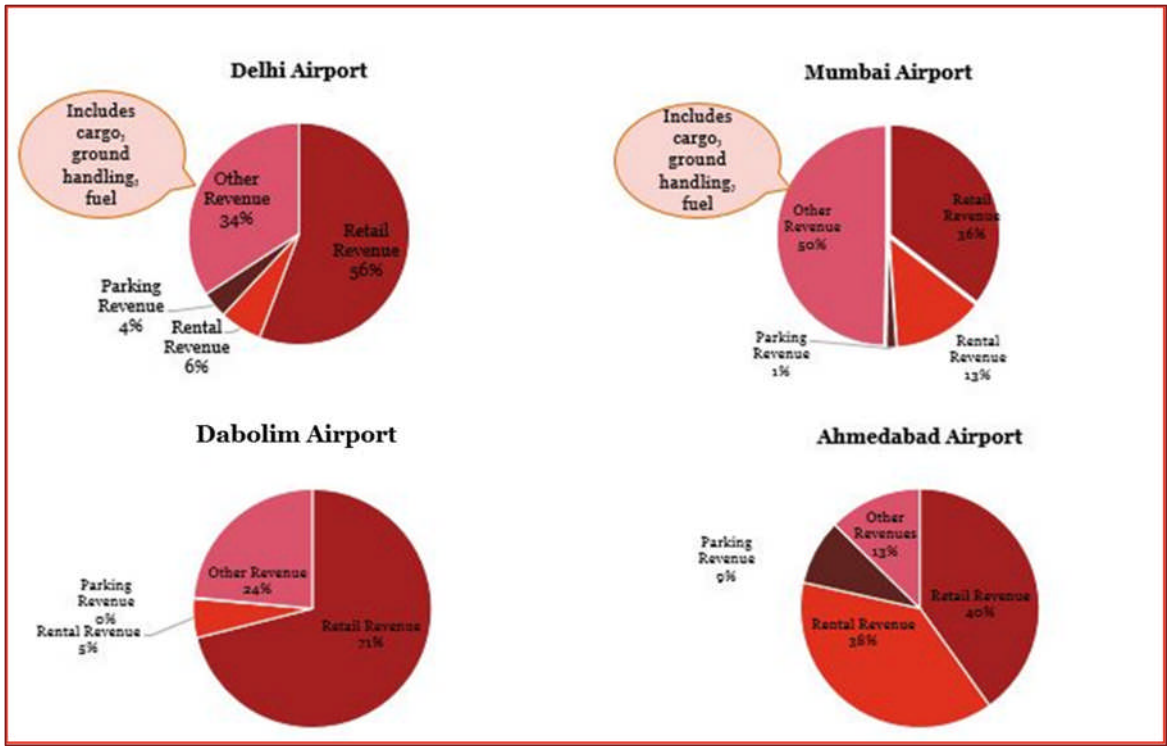
Figure 64: Time spent by Indians at airports (hours)



Source: DGCA

Apart from the passenger's profile, non-aeronautical revenue earning capacity of an airport differ by the nature of services provided at the airport. In general, airports generally drive their non-aeronautical income from retail (duty free, non-duty free), rental revenue, in-flight kitchen, lounge facility, food and beverages etc.

Figure 65: Revenue breakup at select airports in India

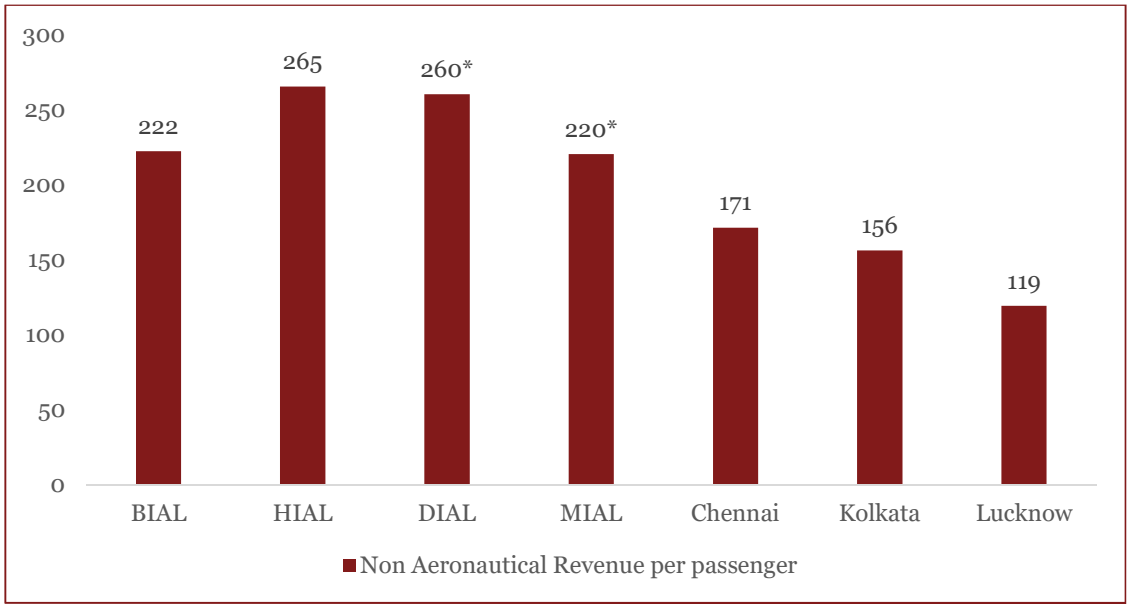


Source: Primary research, secondary research, PwC analysis

6.3. Trends observed at PPP airports

Private operators are typically observed to capitalize the commercial land better than the airports managed by AAI. Usually the range of services offered at PPP airports is wider than AAI airports. As observed in the figure below, non-aeronautical revenue per passenger at PPP airports is around 150-270 INR per passenger compared to 100-180 INR at AAI airports.

Figure 66: Non-aeronautical revenue for major Indian airports (INR per passenger)

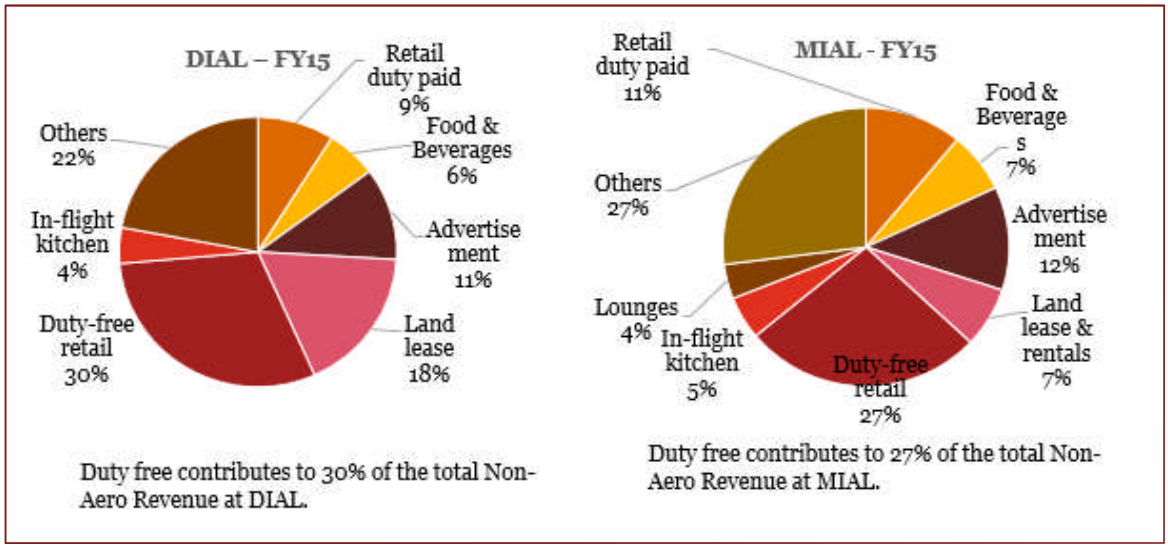


Note: Prices are at 2015-16 levels. Non-Aeronautical revenue for DIAL and MIAL are as per their filing with AERA

Source: Primary research, secondary research, PwC analysis

In terms of revenue generation, most of these airports seem to be driving their revenue from duty-free sale. Other than duty free, land lease rentals and advertisements also command a considerable share in non-aeronautical revenue. Figure 67 provides revenue break-up of two PPP airports.

Figure 67: Breakup of non-aeronautical revenue at Delhi and Mumbai airports



Note: DIAL- Delhi International Airport Limited, MIAL- Mumbai International Airport Limited

Source: Primary research, secondary research, PwC analysis

The following table illustrates that revenue earned by different category of services provided at the airport. Revenue from these services is dependent on the nature of passenger expected at the airport. For instance, earning from duty free shops, forex, etc., is driven by international passengers arriving at the airport. On the other hand, income from sources such as food and beverages is dependent solely on the volume of traffic coming at the airport.

Table 10: Comparison of non-aeronautical revenue breakup for select airports (INR)

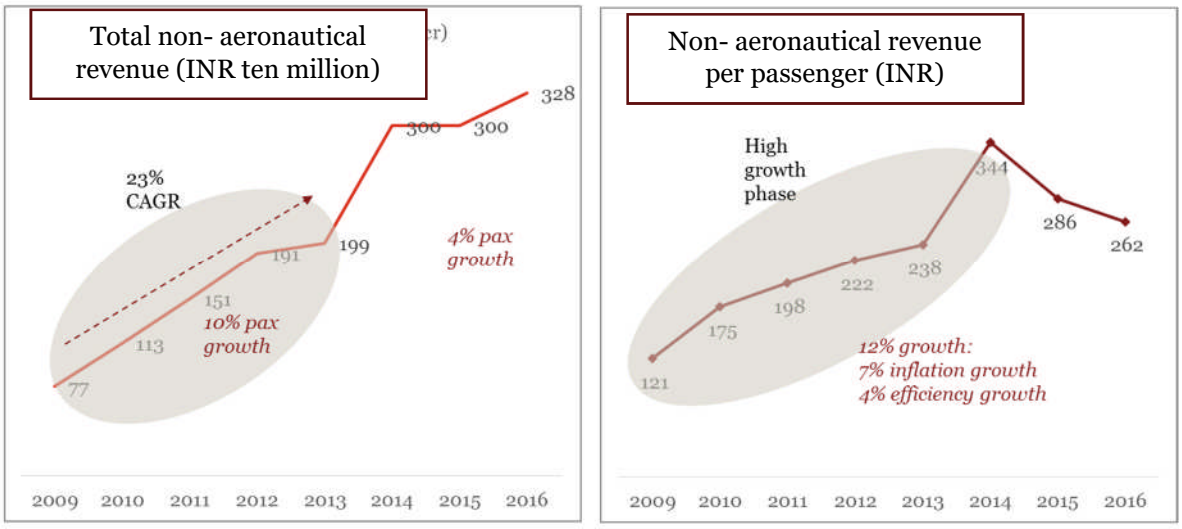
Services offered	Non-aeronautical revenues (DIAL) (2013-14)	Non-aeronautical revenues (MIAL) (2014-15)	Non-aeronautical revenue (HIAL) (2014-15)
Per international passenger			
Duty-Free Sales	194.8	149.6	120.9
Forex	37.9	43.7	20

Per passenger			
Advertisement	24.4	20.7	15.5
Food & Beverage	13	12.6	9.5
Retail Revenue	19.8	19.7	12.3
Car Park	2.7	3.8	16.4
Public Admission Fee	-	-	5.3
Car Rental and Radio Taxi	4.6	4.1	6.1
Transit Hotel	0.8		36 (Hotel – Not Transit Hotel)
Others (Communication, ATM, Travel Services, etc.)	17.4	14.2	28.8
Per embarking passenger			
In-flight Kitchen	19	17.5	10.6
Lounge	11.4	14.7	7.1

Note: DIAL- Delhi International Airport Limited, MIAL- Mumbai International Airport Limited, HIAL – Hyderabad International Airport Limited
Source: Primary research, secondary research, PwC analysis

However, it is important to note that in the initial part of the concession, non-aeronautical revenue is typically observed to show supernormal growth. This growth is largely due to the change in the profile of the passenger coming at the airport and also, the nature of services available at the airport is also not stabilized. This trend is observed in most the PPP airports. For instance, Hyderabad airport commenced operations in 2009. It is observed that during the initial 5-8 years, the growth rate of non-aeronautical revenue was 25% CAGR while the passenger growth rate was only 10%. Further analysis reveals that non-aeronautical revenue per passenger during this period grew at 12% CAGR. Of that 7% is accounted by the inflation led growth and the remaining 4% is accounted by efficiency growth.

Figure 68: Non-aeronautical revenue trends at Hyderabad Airport



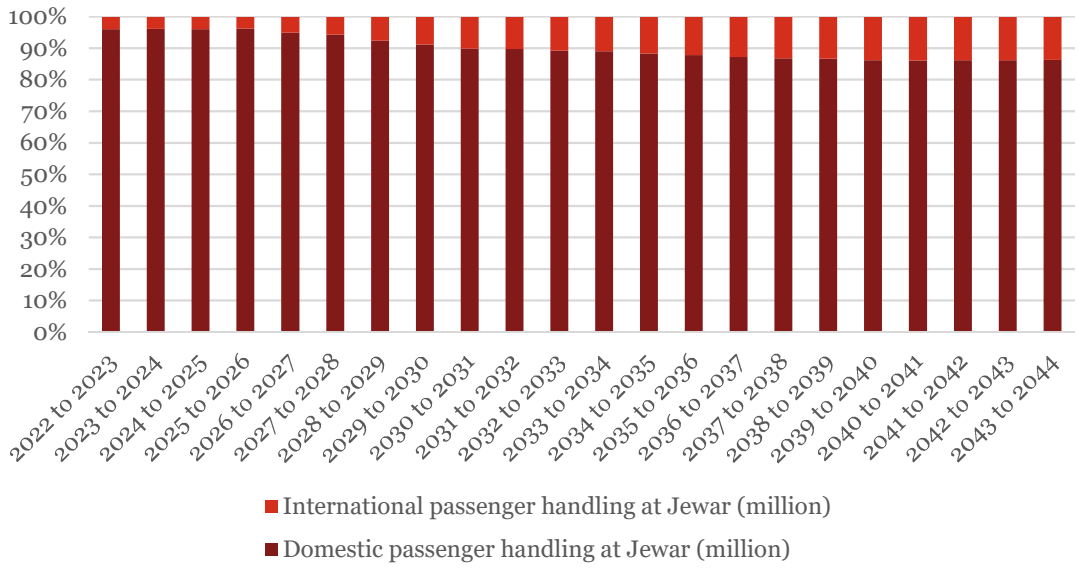
Source: AERA, PwC analysis

This indicates that during the initial years of operation of an airport, the growth in the non-aeronautical revenue per passenger could be attributed to inflation and the level of efficiency. Post stabilization of operations, the non-aeronautical revenue typically grows by passenger growth and rate of inflation.

6.4. Non-aeronautical revenue potential at Jewar Airport

The passenger profile at the Jewar airport is likely to have a direct bearing on the non-aeronautical revenue earning potential of the airport. Higher dwell time spend by international passenger at the airport is likely to increase their propensity to spend at the airport. Similarly, leisure passenger are also likely to spend higher at the airport when compared to business passenger.

Figure 69: Traffic profile at Jewar



As per the traffic analysis, the share of international passenger is expected to rise from 1.2 million in 2023 to 10 million by 2040. With ramp up in the international passenger at Jewar airport, the non-aeronautical revenue is also expected to increase.

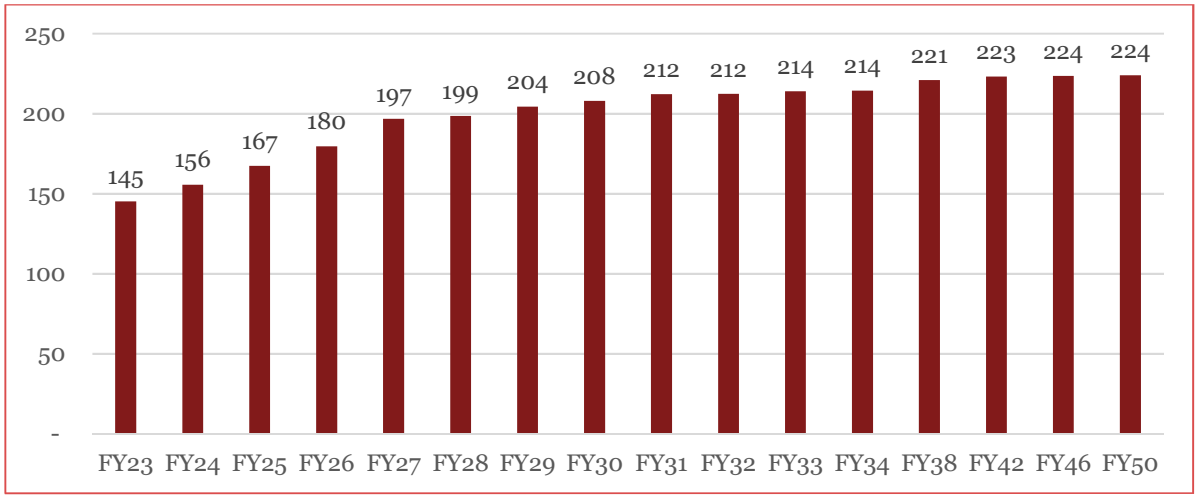
Given the proposed airport at Jewar is in the same hinterland as IGI airport, the services expected to be offered at the proposed Jewar airport is expected to similar to IGI. The table below illustrates the category of services that are expected to be offered at the airport.

Figure 70: Category of services at Jewar

Particulars	2018-19
Duty Free revenue per international passenger	254
Foreign exchange revenue per passenger - International	45
Bank / ATM revenue per passenger	4
Advertisement revenue per passenger	27
Miscellaneous revenue per passenger	15
Flight kitchen revenue per embarking passenger	20
Retail revenue per passenger	24
Food & Beverage revenue per passenger	14
Lounge revenue per embarking passenger	12
Cark parking per passenger	4
Car rental & reservations per passenger	5
Transit hotel	30

Given the nature of services and the passenger profile, Jewar airport is expected to make a non-aeronautical revenue of around 145 INR per passenger (at FY18 prices) at the start of operations which is expected to stabilize to 200 INR (real prices at FY2018 levels) by FY28.

Figure 71: Non-aeronautical revenue per passenger



Note: Price are at 2018 levels

Source: PwC analysis

7. City side and MRO

The total land reserved for city side development is around 24 hectare and for commercial development like MRO is around 40 hectare. The main objective of this section is to provide potential areas for which the earmarked land can be utilized. The evaluation is based on comparative analysis of other PPP airports in India along with market demand assessment.

7.1. Off-take pattern at other PPP airports

In order to improve the commercial viability of an airport, commercial land is often bundled with an airport. The city side land demarcated for Rajiv Gandhi International Hyderabad airport was around 600 hectare compared to 409 hectare in Kempegowda International airport, Bangalore and 283 hectare in Cochin International Airport. However, as assessment of the land off-take pattern of existing airports shows an insignificant off-take of land. Off-take at Rajiv Gandhi International Hyderabad Airport has been around 108 hectare, even after 8 years of being in operation. Similarly, off-take in Bangalore is only about 6.5 hectare and 91 hectare in Cochin.

Given the land off-take trend, size of the land parcel along with the airport is limited to only about 5 percent of the total airport land.

7.2. Commercial development opportunity at Jewar

Under Delhi-Mumbai Industrial Corridor, Government is developing Dadri-Noida industrial corridor. The belt is home to some of the largest companies in India, engaged in the manufacturing of process cars, auto parts, two-wheelers, engineering products, consumer electronics, steel etc. The proposed airport at Jewar is only about 50-55 km from Dadri region. Given close proximity to an industrial belt, allocation of city-side land for industrial development may not be feasible as land near the airport is likely to be more expensive than industrial land. Instead, the proposed land can be used for development of following facilities:

- MRO facility
- Other commercial development comprising of:
    - Convention center
    - Aviation training institutes
    - Hospitality

7.2.1. MRO facility

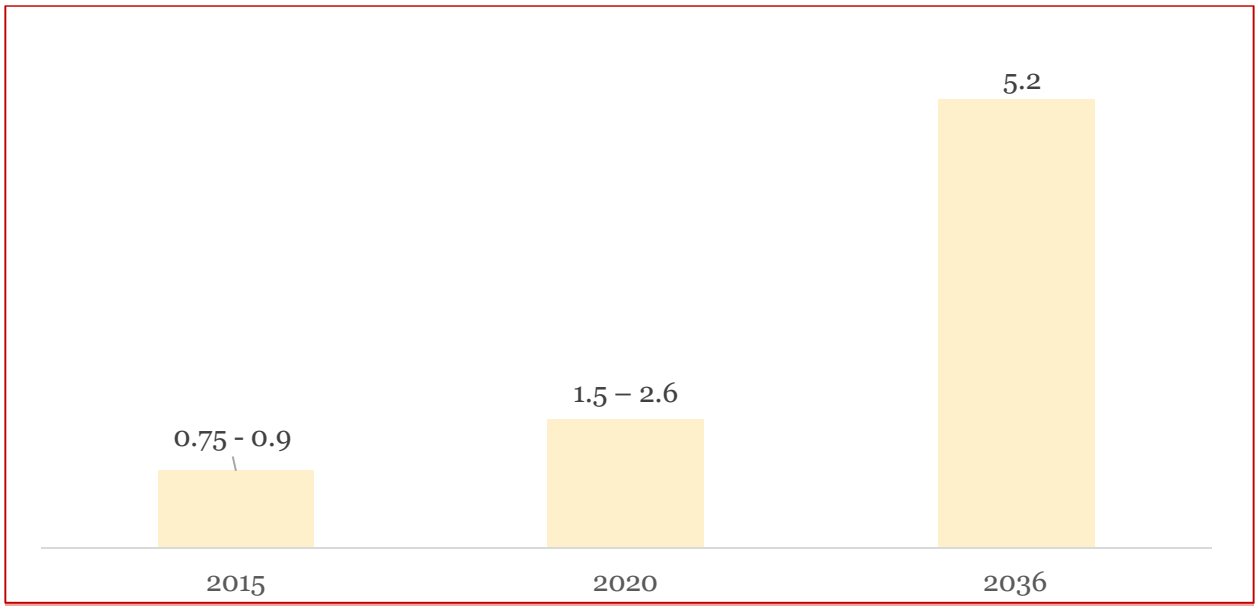
The MRO market demand arising out of India is valued at 1 billion USD and is expected to go up to 5 billion USD by 2036. It may be noted that only 10 percent of the MRO market is currently captured

within India, with the remaining being done outside the country. The Govt. of India, through the National Civil Aviation Policy (NCAP), has put in effort towards the promotion of a domestic MRO industry.

The NCAP has recognized that the taxation policy in India with regard to aircraft parts for MRO activities has been a major hindrance towards the development of the MRO industry. Thus, the Policy recommends an overhaul in the taxation regime involving this sector. For example, the tools and tool-kits used by the MRO Industry have been exempted from Customs Duty.

The NCAP is also cognizant of the fact that developing this industry, which is at present in its nascent stage, will require skill transfer to the domestic units. To cater to the same, the Policy also considers liberalizing the visa regime for MRO experts.

Figure 72: Existing and projected MRO market arising out of India (billion USD)



Source: Indian Aircraft MRO Market, Defence ProAc, Indian Aviation 2016, FICCI, and India MRO Forum

Most of the MROs in India provide only A & B check services. For advanced services, airlines use MRO hubs in South East Asia, Sri Lanka and Middle East. Most of the scheduled commercial airlines in India have long-term contracts with MRO service providers abroad. Thus, for a new Indian MRO player to service an airline in India, the contract expiry of that airline with its existing MRO service provider will act as a window of opportunity to provide services.

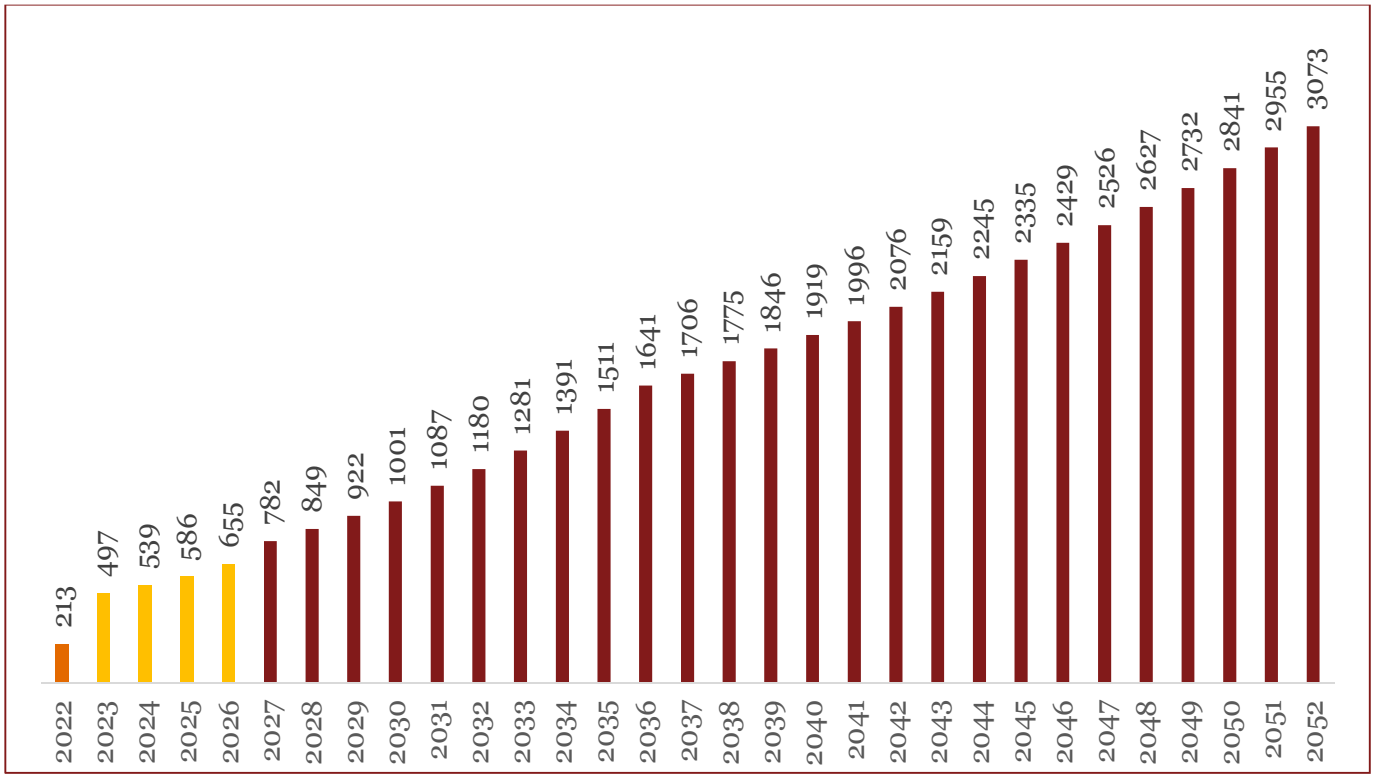
Table 11: Overview of airlines in India and their MRO contracts

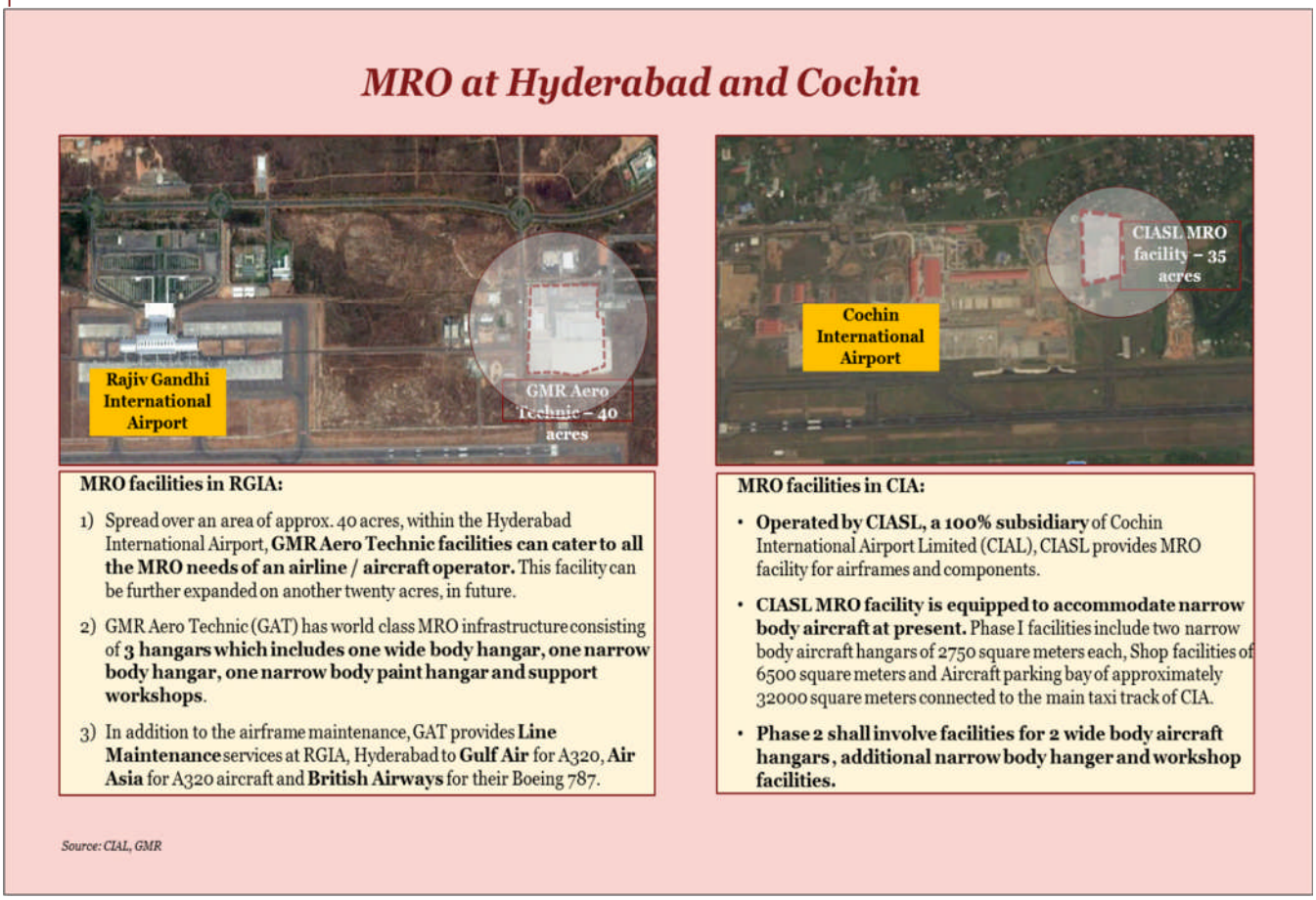
Airline	MRO service provider	Existing contract	Year of expiry	remarks
Air India	AIESL, India	Air India's fleet is serviced at **its own MROs** in Hyderabad, Nagpur, Delhi, Kolkata, Hyderabad and Thiruvananthapuram. **Consultation with AIESL** suggests that they plan to service other airlines as well.		
Spice Jet	SR Technics, Zurich and AIESL, India	**10-year contract** signed with SR Technics in 2012; additionally, MoU Signed with AIESL for its Nagpur facility in 2016.	2022 (with SR Technics)	The duration under MoU with AIESL is not available; however, talks to service additional 100 aircraft of Spice Jet, which may be acquired by 2030, are going on.
Indigo	Sri Lankan Airlines, Sri Lanka and Air France KLM E&M	Initial contract signed with Sri Lankan airlines for C-checks in 2009 was renewed in 2014. Also, initial contract signed with Air France KLM E&M in 2007 extended in 2013	2020	The contracts are **long-term contracts**, but the years of expiry are not available, so have been assumed to be 2019 (based on previous contract periods); talks with Air France KLM E&M are going on to service Indigo fleet acquired in 2016
Jet Airways	ST Aerospace, Singapore and Honeywell Aerospace	Initial **10-year contract** signed with ST Aerospace in 2010 replaced with a **6-year contract** signed in 2015. Additionally, a **5-year contract** signed with Honeywell for its Boeing 777 fleet.	2022	-
Go Air	Lufthansa Technik, Germany	Initial **10-year contract**, signed in 2012, extended in 2016 for **10 years.**	2026	-
Air Asia	Air France KLM's MRO, France	Initial **5-year contract**, signed in 2009 was extended in 2013 and later in 2016 for **10 years**.	2026	-
Vistara	Airbus and Pratt & Whitney (P&W)	A **long-term contract** with Airbus signed in 2015 for maintenance. Additionally, engine maintenance contract signed with Pratt and Whitney. A **14-year contract** signed with Air Works for line maintenance.	2020	The contract with Airbus is **a long-term contract**, but the duration is not available, so has been assumed to be 5 years.

Source: Primary interactions

Considering the existing MRO contracts and their structure, it may be noted that beyond 2022, due the expiry of existing contracts, an opportunity for Indian MRO players to capture the existing demand will present itself.

Figure 73: Number of aircrafts available for MRO services in India (considering expiry of existing MRO contracts)





Given the likely demand trends along with the MRO facilities operating at the other airports, around an area of 40 hectares has been allocated for MRO services in the Jewar Airport masterplan.

7.2.2. Other commercial facilities

Out of the total commercial land, around 20% of the land would be utilized for access road and other utilities. The remaining land may be used for other commercial purposes such as hotels, convention centers, cargo facilities etc. Table 12 provides options for potential use of land.

Table 12: Potential areas for commercial use

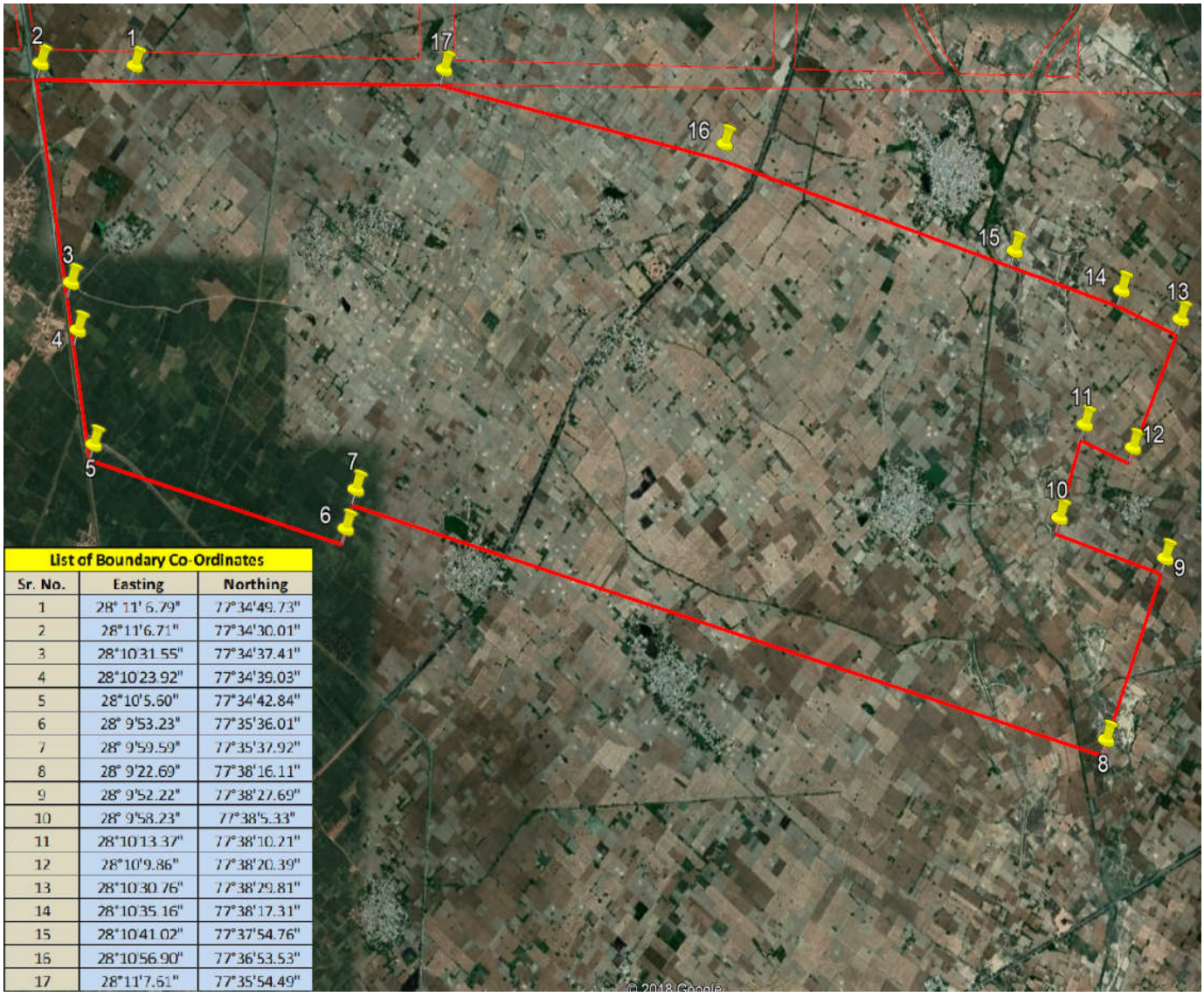
Product mix	Potential land use	Benchmark
• Midscale Hotels • Upscale Hotel (4/5 Star Hotels) • Luxury Hotels (Beach Resorts) • Restaurants	Around 4 hectare	• Novotel Hotel spread over area of 1.5 hectare, was opened around 2009 (1 year after COD) • Taj Bangalore spread over 1.5 hectare started its operation around 2015 (7 years after COD)

Product mix	Potential land use	Benchmark
• Training institute	Around 1.5-2 hectare	• GMR School of Business and Aviation (Asia Pacific Flight Training) academy is spread over 2 hectare. • CIA also has an Aerospace academy spread over 1.2 hectare.
• Convention Cum Exhibition Centre	Around 2 hectare	• CIAL exhibition center is spread over 2.5 hectare
• Commercial District o Commercial office space o Retail space	Around 2 hectare	• GMR Aero Towers in RGIA is operational with an area of approx. 2 hectare

8. Master planning

In the first stage of development, an area of 1334 hectare has been earmarked for development of Jewar Airport. The exact geographical spread of the area is depicted in the following figure:

Figure 74: Geographical spread of the airport area



List of Boundary Co-Ordinates		
Sr. No.	Easting	Northing
1	28° 11' 6.79"	77°34'49.73"
2	28°11'6.71"	77°34'30.01"
3	28°10'31.55"	77°34'37.41"
4	28°10'23.92"	77°34'39.03"
5	28°10'5.60"	77°34'42.84"
6	28° 9'53.23"	77°35'36.01"
7	28° 9'59.59"	77°35'37.92"
8	28° 9'22.69"	77°38'16.11"
9	28° 9'52.22"	77°38'27.69"
10	28° 9'58.23"	77°38'5.33"
11	28°10'13.37"	77°38'10.21"
12	28°10'9.86"	77°38'20.39"
13	28°10'30.76"	77°38'29.81"
14	28°10'35.16"	77°38'17.31"
15	28°10'41.02"	77°37'54.76"
16	28°10'56.90"	77°36'53.53"
17	28°11'7.61"	77°35'54.49"

8.1. Planning philosophy

The Planning philosophy for Jewar Airport development is driven by the following considerations:

- Proposed Jewar Airport along with IGIA shall be a two airport system for NCR. Therefore, planning of Jewar Airport needs to be based on ensuring synergy between two airports. The synchronization shall be in terms of air space management and airport operations to derive maximum benefits for passengers and stakeholders.

- Jewar Airport is aimed at creation of a world class, futuristic airport providing direct air connectivity, a very wide domestic and international network, and a seamless passenger travel experience.
- Jewar Airport Passenger Terminal shall be the most visible and iconic element of Jewar Airport's development, an architectural landmark exhibiting unique futuristic architectural language. Although Jewar Airport Passenger Terminal shall be developed in phases in accordance with traffic demand, it shall be designed to emerge as a unified, integrated architectural form, composed of smaller terminals built in different phases but seamlessly interconnected at various levels.
- The proposed Draft Master Plan for Jewar Airport is designed for the capacity of 70 million passengers per annum. It is however essential to explore feasibility of enhancing Jewar Airport capacity beyond that to serve long term demand arising out of the hinterland.
- Jewar Airport shall be planned and developed considering upgrades to existing airport operation processes, with enhanced integration of emerging and innovative IT processes for more efficient, secure, and faster airport operations, with required service quality standards supported by state of the art facilities.
- The proposed Jewar Airport Master Plan shall provide direction for long term development of required airside, terminal, landside and cargo uses, safeguarding the land for future long-term airport needs, for aeronautical and non- aeronautical services.
- As an airport for the future, Jewar Airport shall be developed as a Green Airport, with key objective of environmental sustainability through energy optimization, re-cycling of waste, reduction in carbon foot print, utilization of solar energy, natural day lighting along with other sustainable measures in planning, development, and operation of Jewar Airport.

Phasing of the project is driven by cost efficiency considerations and also the fact that Jewar Airport must maintain a competitive tariff against an existing airport.

8.2. Planning norms

In preparing this master plan, we have carefully considered the policy and the legislative framework which would directly or indirectly influence the airport's future development and growth. The exercise seeks to provide an overview of possible airport development and its ultimate estimated capacity.

The proposed master plan and development plan(s) for each phase, primarily conform to Standards and Recommended Practices (SARPs) formulated by the International Civil Aviation Organization (ICAO) and promulgated by Directorate General of Civil Aviation (DGCA), India. The plans also simultaneously seek meeting the aspirations of the all stake holders and Service Levels. As regards area computations for the terminals, the recommendations of the Inter Ministerial Group (IMG) are also taken into consideration. It needs no emphasis that the IMG norms were framed while the latest

reporting time at check-in counters was 30 minutes, which has subsequently been raised to 45 minutes, consequently increasing the time spent by passengers at an airport and the resulting pressure on the facilities.

The operational and functional requirements specified in this document are to enable appreciation of the various facets / aspects considered, including the regulatory requirements, for design and placement. Master plan preparation process for the international airport at Jewar takes into considerations, broadly the following parameters:

- Projected air traffic demand (passengers, cargo, mail, GA and aircraft)
- Meteorological data - wind (direction/speed), temperature, rainfall, and visibility conditions
- Geotechnical investigation.
- Airside facilities requirements
- Passenger and Cargo terminal capacity and broad facilities proposed to be provided.
- Performance Characteristics of the type of aircraft to be operated at the airport
- Airside facilities like area for Ground Support Equipment, remote parking bays, isolation bay etc.
- Areas for MROs and FBOs.
- Aircraft refueling facilities
- Safety services like firefighting facilities and medical services.
- ATC Tower ,CNS and Met facilities and electronic landing aids
- Airfield Ground Lighting facilities and visual aids for navigation and landing.
- City side Facilities like premium car park, general car park, taxi parking, bus parking areas.
- Area for sovereign and security services
- Area for support services like electric power substation, water treatment plant, sewage treatment plant etc.

- Airfield drainage system,
- Road and rapid transit (Metro) access to airport .

8.3. Airport facility requirements

JIA is planned as a state-of-the-art airport, with modular facilities for both domestic and international passengers and cargo capacity to accommodate the maximum possible projected demand for all weather operations. The facilities planned include passenger and cargo terminal buildings, runway system, aprons, taxiways, airfield lighting system, air traffic control tower, NAVAIDs, airport support facilities, utilities and infrastructure including roads, car parking, power supply system, storm water drainage system, sewage treatment plant, etc., and aircraft support facilities like refueling, repairs and overhaul, ground support, and catering etc.. It is essential to define JIA design requirements at the conceptual design level for the airport infrastructures and facilities, based on the planning criteria in accordance with the norms and recommendations provided by different regulatory authorities (DGCA, BCAS etc.), and other agencies specialized in airport planning (ICAO, IATA, etc.) and considering the consultant team's experience in similar processes involved in the planning of a new airport.

Design/facility requirements are the outcome of the application of technical norms and service level standards to the relevant forecast data throughout the planning period to ensure that sufficient facilities are available to accommodate the forecast traffic volumes from the beginning of the airport operation to the end of the planning horizon. A robust traffic forecast, therefore is the fundamental necessity.

8.3.1. Traffic, fleet mix, and design capacity

As mentioned above, traffic forecast provides the basis for the long-term planning of airport facilities. The forecasts indicate the type and size of facilities required and the appropriate phasing of these facilities. On the basis of annual passenger demand and the expected traffic density variation throughout a day at Jewar Airport, the following table depicts the year on year peak capacity requirements for passenger as well as aircraft handling.

Table 13: Estimation of peak hour passenger and aircraft handling demand at Jewar airport

Year	Domestic passenger handling at Jewar (million, annual)	International passenger handling at Jewar (million, annual)	Total passenger handling at Jewar (million, annual)	Peak aircraft movement (arrivals and departure) in an hour	Peak passenger handling in an hour	Peak domestic passenger handling in an hour	Peak international passenger handling in an hour
2022 to 2023	4.49	0.20	4.87	10	1058	1050	63

2023 to 2024	5.27	0.22	5.70	11	1285	1276	73
2024 to 2025	5.74	0.25	6.24	12	1474	1459	79
2025 to 2026	6.78	0.29	7.35	17	2249	2220	96
2026 to 2027	8.00	0.45	8.78	18	2396	2346	113
2027 to 2028	10.14	0.64	11.17	24	3062	2978	141
2028 to 2029	12.60	1.09	14.13	24	2981	2858	168
2029 to 2030	14.72	1.49	16.70	29	3843	3641	251
2030 to 2031	18.40	2.16	21.11	31	3916	3660	312
2031 to 2032	20.89	2.47	23.98	36	4230	3935	355
2032 to 2033	23.94	3.00	27.62	38	4738	4370	437
2033 to 2034	26.29	3.35	30.37	39	5190	4763	500
2034 to 2035	28.42	3.89	33.11	43	5685	5166	602
2035 to 2036	32.66	4.70	38.22	50	6613	5950	765
2036 to 2037	36.46	5.53	42.92	56	7517	6716	928
2037 to 2038	40.44	6.33	47.76	63	8195	7288	1055
2038 to 2039	43.52	6.89	51.48	68	8449	7499	1108
2039 to 2040	46.43	7.64	55.19	70	8990	7940	1227
2040 to 2041	49.45	8.21	58.85	74	9546	8419	1320
2041 to 2042	52.90	8.70	62.86	79	10184	8987	1405
2042 to 2043	56.14	9.29	66.76	84	10777	9500	1502
2043 to 2044	60.21	9.88	71.50	91	11356	10017	1578
2044 to 2045	63.65	10.48	75.61	96	11948	10531	1672
2045 to 2046	67.17	11.08	79.82	101	12595	11095	1773
2046 to 2047	70.78	11.50	83.92	107	13294	11729	1852
2047 to 2048	74.93	11.91	88.57	113	14080	12451	1931
2048 to 2049	78.73	12.64	93.19	118	14128	12475	1961
2049 to 2050	82.53	13.37	97.81	123	14176	12499	1991

The fleet mix expected at Jewar Airport has also been estimated so as to enable effective planning for the airport. The following table depicts the expected fleet mix over the years.

Table 14: Fleet mix expectations at Jewar Airport

Year	Code A/B	Code C	Code D	Code E/F
2022 to 2023	7%	91%	0%	2%

Year	Code A/B	Code C	Code D	Code E/F
2023 to 2024	7%	91%	0%	2%
2024 to 2025	7%	91%	0%	2%
2025 to 2026	7%	91%	0%	2%
2026 to 2027	7%	90%	0%	2%
2027 to 2028	7%	90%	0%	3%
2028 to 2029	7%	89%	0%	3%
2029 to 2030	7%	89%	0%	4%
2030 to 2031	7%	88%	0%	5%
2031 to 2032	7%	88%	0%	5%
2032 to 2033	7%	88%	0%	5%
2033 to 2034	7%	88%	0%	5%
2034 to 2035	7%	88%	0%	5%
2035 to 2036	7%	87%	0%	6%
2036 to 2037	7%	87%	0%	6%
2037 to 2038	7%	87%	0%	6%
2038 to 2039	7%	87%	0%	6%
2039 to 2040	7%	87%	0%	6%
2040 to 2041	7%	87%	0%	6%
2041 to 2042	7%	87%	0%	6%
2042 to 2043	7%	87%	0%	6%
2043 to 2044	7%	87%	0%	6%
2044 to 2045	7%	87%	0%	6%
2045 to 2046	7%	87%	0%	6%
2046 to 2047	7%	87%	0%	6%
2047 to 2048	7%	87%	0%	6%
2048 to 2049	7%	87%	0%	6%
2049 to 2050	7%	87%	0%	6%

Based on the planning philosophy stated above, and the financial prudence, the traffic forecast suggests that the airport be developed in four phases. The phasing has been suggested so that the service levels, airport capacity and operational efficiency will not be compromised at any stage of development. The planning principles ensure that the forecasted demand can be accommodated with the planned capacity to sustain its operations at an acceptable level of service and minimum operational delays. It is envisioned the opening day demand of the airside facilities will operate at 50% of their planned capacity, based on the forecast activity levels.

Table 15: Development phases for Jewar Airport

Development Period	Phase	Name	Operation Period	Design Year	Design Facility Capacity		
					Passengers	Cargo	ATM
FY20-FY22	Phase 1	Opening	FY23-FY27	FY28	12 MPPA	0.75MT	24
FY28-FY30	Phase 2	Short Term	FY31-FY32	FY34	30 MPPA	1.00MT	40
FY33-FY35	Phase 3	Medium Term	FY36-FY37	FY39	50 MPPA	1.5 MT	68
FY37-FY39	Phase 4	Long Term	FY40-FY50	FY44	70 MPPA	2.0 MT	85

Note: MPPP: million passengers per annum, MT: million ton, ATM capacity is in terms of maximum aircraft movement hourly capacity

As mentioned previously, the approach, to assure that adequate facilities are available when needed to meet forecasted demand with adequate level of service, is to plan facilities for the traffic forecasted in the future, so improvements needed in the near future would be designed for implementation sufficiently in advance, providing flexibility in case of faster- than-projected growth.

An important factor that must be considered in determining the required facilities to be built beyond the initial phase is the Investment or Capital Expenditure required by Jewar Airport in the years after the effective date of the airport commissioning. The staging of development works shall be cited by the growth in demand beyond what can be accommodated by the initial phase facilities.

For the estimation of the extent/volume/capacity requirements of the different airport subsystems, the air traffic forecast in the horizon periods is used for passengers, cargo and aircraft, as shown in following table.

Table 16: Air traffic forecast at Jewar Airport

	Opening	Short-Term	Medium- Term	Long-Term
International Commercial Aircraft Operations	4015	19710	40880	58400
Domestic Commercial Aircraft Operations	96868	239945	393678	542800
Total Commercial Aircraft Operations	100883	259655	434558	601200
Cargo Aircraft Operations	6508	8494	12024	14898
Total Aircraft Operations	107391	268149	446582	616098
Intern. Terminal Commercial Passengers ('000)	640	3350	6890	9880
Dom. Terminal Commercial Passengers ('000)	10140	26290	43520	60210
Other Commercial Passengers ('000)	380	730	1060	1410
Total Passengers ('000)	11160	30370	51480	71500
International Aircraft Peak Hour	1	3	8	11
Domestic Aircraft Peak Hour	23	36	61	81
Total Aircraft Peak Hour	24	39	68	91
International Passenger Peak Hour	141	500	1108	1578
Domestic Passenger Peak Hour	2978	4763	7499	10017
Total Passenger Peak Hour	3062	5190	8449	11356

8.3.2. Airport classification

While traffic forecast, quality of service levels etc. relate to sizing of various services and facilities at an airport; physical size, geometrical design, performance and aircraft characteristics are some of the other major considerations in planning for layout of the facilities, particularly on the airside of an airport. In view of very wide range of physical and performance characteristics of aircraft, to ease the process of planning and operations, ICAO has introduced a system of classification through allocation of an Aerodrome Reference Code. The reference code provides a method of inter-relating the numerous specifications concerning the characteristics of aerodromes so as to provide a series of aerodrome facilities that are suitable for the airplanes that are intended to operate at the aerodrome. The code comprises of two elements which are related to the airplane performance characteristics and dimensions. Element 1 is a number based on the airplane reference field length and element 2 is a letter based on the airplane wingspan and outer main gear wheel span. A particular specification is related to the more appropriate of the two elements of the code or to an appropriate combination of

the two code elements. The code letter or number within an element selected for design purposes is related to the critical airplane characteristics for which the facility is provided.

Considering the traffic forecast, and the type of airplane (Airbus 380) likely to operate at Jewar Airport, it is established that the airport must be planned for Code 4F operations.

8.3.3. Siting, orientation, and number of runways

The critical factors that affect the determination of the siting, orientation, and numbers of runways are:

- weather, in particular the runway/aerodrome usability factor, as determined by wind distribution, and the occurrence of localized fogs;
- topography of the aerodrome site and its surroundings;
- type and amount of air traffic to be served, including air traffic control aspects;
- airplane performance considerations; and
- environmental considerations, particularly noise.

In the previous report submitted by L&T Ramboll, the weather factor was examined based on IMD data for Safdarjung Airport as the data from the Jewar site was not available. Further, based on the runway orientation decided earlier, geographical boundary of the airport site was delineated.

Detailed weather data pertaining to wind speed/direction and temperature for Jewar village has now been compiled. However; the data obtained now can't be validated as the previous data utilized by L&T Ramboll is not available.

Data about localized fog is not available as the IMD does not have any observatory in that area. It has been learnt that the fog in winter often reduces the general visibility to a great extent. A detailed study of the data obtained now affirms, the conclusion arrived at the earlier version of the TEFR. Hence, the suggested orientation of 10/28 has been maintained.

8.3.4. Obstacle Limitation Surfaces (OLS)

In order to maintain the airspace surrounding the airport free of obstacles, DGCA CAR defines the following OLS for airports code 4F with precision approach procedures:

a) Conical surface

b) Inner horizontal surface

c) Approach surface

d) Inner approach surface

e) Transitional surface

f) Inner transitional surface

g) Balked landing surface

The surfaces c, d, e, f, and g directly impact the runway requirements at Jewar Airport. The obstacle limitation surfaces are designed to be permanent and to ensure their effectiveness, so the OLS have to be included in laws or local decrees for land use and/or construction.

Conical Surface

The conical surface is an ascending slope surface and outwards of 5% that extends 250 meters upward from the periphery of the inner horizontal surface.

Inner Horizontal Surface

The inner horizontal surface is a surface located in a horizontal plane on the aerodrome and its environs. The radius or outer limits of the inner horizontal surface is 4,000 m for Code 4 airports measured from the runway thresholds/extremity and 45 meters height measured from the airport reference elevation. The slope of the inner horizontal surface is 1:7.

Transitional Surface

The purpose of the transitional surface is to serve in all cases as the obstacle limitation surface for buildings and fixed objects, including parked aircraft at the apron. The slope of the transitional surface of 14.3% for precision approach runways of code number 4 is measured in a perpendicular vertical plane to the runway centerline from the edge of the runway strip and outwards.

Inner Transitional Surface

These surfaces are similar to those of the transitional surfaces but are closer to the runways. Their limits are: a lower edge stretching from the side edge of the inner approach surface to its inner edge and from there all along the strip, running parallel to the runway, to the inner edge of the balked landing surface, moving on along the side edge of such surface to the horizontal surface; and an upper edge that lies in the inner horizontal surface. The slope of this surface is 33%.

Approach Surface

The approach surface is an inclined plane or combination of planes ahead of the threshold. The approach surface's divergence required for a Code Number 4 precision approach runway is 15% with

a length of the inner edge of 300 m and a distance from the threshold of 60 m. The first section of the approach surface must have a length of 3,000 m and a slope of 2%.

Inner Approach Surface

It is made up of a rectangular part of the approach surface with the following limits: an inner edge matching the inner edge of the approach surface but 120 m long; two sides stretching out from the inner edge end and spread parallel to the vertical plane containing the runway centerline; and an outer edge that runs parallel to the inner edge at 900 m.

Balked Landing Surface

This surface has the following limits: an inner horizontal edge running perpendicularly and at the level of the runway centerline, located 1,800 m after the threshold; two sides coming out from the inner edge end and diverging by 10% from the vertical plane that contains the runway centerline; and an outer edge at the inner horizontal surface. The slope of this surface is 3.33%.

8.3.5. Airfield safety requirements

8.3.5.1. Runway strip

DGCA CAR states that the land comprising within the Runway strip of uniform width of 150 meters on either side of centerline which extends to 60 meters beyond each extremity of Runway, along the extended centerline of a Runway of code 4, equipped with Instrument Approach Procedure, and must be kept free of any obstacle.

8.3.5.2. Runway end safety area

A safety area symmetrical about the extended runway centerline and adjacent to the end of the strip primarily intended to reduce the risk of damage to an airplane undershooting or overrunning the runway. The runway end safety area should, as far as practicable, extend from the end of a runway strip to a distance of at least 240 m where the code number is 4. The width of the area shall be twice the width of the runway.

An OLS survey of the site was undertaken to assess the objects protruding the OLS. It is noticed that three removable objects, an overhead water tank, a mobile tower and a brick kiln chimney protrude the surface. The detailed OLS report is annexed to this report as Annex ‘A’. Appropriate remedial action is also suggested in the report.

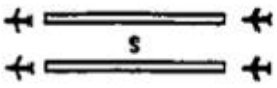
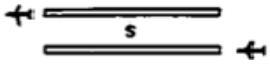
8.3.6. Number of runways

The number of runways is determined by the demand to be satisfied by the Jewar Airport, in compliance with DGCA CAR Section 3, paragraph 3.1.1. The parameter ruling this number is the amount of operations per peak hour using the methods suggested by the FAA US and the guidance

provided in 'ICAO Aerodrome Design Manual, Doc 9157, Part 1 – Runways. Utilizing the guidance provided in FAA's Airport Capacity and Delay publication, Advisory Circular (AC) 150/5060-5, Chapters 2 and 3, several airfield configurations have been reviewed for their capability to provide the Airfield Capacity Required - in terms of number of runways and general airfield configuration – to support the forecast demand at the predetermined mix index.

Chapter 3, Fig. 3-43 of the referenced AC indicates a single runway, adequately equipped (with taxiways, instrumentation, radar coverage, etc.) would have an IFR hourly capacity of approximately 48 operations. Chapter 2, Fig. 2-1, Configuration No. 1 of the referenced AC also indicates a single runway will have an IFR hourly capacity of 50 operations and an annual capacity of 240,000 operations and Configuration No. 4 indicates that a two-runway configuration would provide 99 operations and an annual capacity of 370,000 operations. Even the FAA Airport Capacity & Delay Manual, Fig. 3-51, indicates that a two runway configuration with mixed operations separated more than 1,035 meters, capable of independent and simultaneous operations would provide peak of 98 hourly operations. The following table depicts the hourly capacity of single and parallel runways vis-à-vis the mode of operation. The calculated capacity is the value attributed to the declared airport capacity or the result of applying a 90% to the value of the FAA capacity. In most of the cases it coincides with the declared runway capacity, which is defined as the maximum number of daily operations that can be programmed in an airport so that the delay indicators do not surpass admissible limits as the number of airport operations increase.

Table 17: Summary of hourly capacity by runway configuration and mode of operation

Runway Configuration **Figure**	**Mode of Operation**	**Calculated Runway Capacity (Average delay 4min. - 2hrs peak) Arrivals**		
		40%	**50%**	**60%**
	Only arrivals	44	44	44
	Mix arrivals & departures	47	46	45
	Both for arrivals & departures	90	88	84
	One for arrivals only One for departures only	65	71	71

There are two commonly used definitions of runway capacity: "throughput" and "practical capacity." The throughput definition of capacity is the rate at which aircraft can be handled—i.e., brought into or out of the airfield, without regard to any delay they might incur. This definition assumes that aircraft will always be present waiting to take off or land, and capacity is measured in terms of the number of such operations that can be accomplished in a given period of time. 'Practical capacity' is the number

of operations (takeoffs and landings) that can be accommodated with no more than a given amount of delay, usually expressed in terms of maximum acceptable average delay. Practical Hourly Capacity (PHOCAP) and Practical Annual Capacity (PAN-CAP) are two commonly used measures based on this definition. PANCAP, for example, is defined as that level of operations which results in not more than 4 minutes average delay per aircraft in the normal peak 2-hour operating period.

The unconstrained aircraft movement forecast suggests that within 10 years of airport's opening, the aircraft movements in peak hour is likely to exceed 45 numbers, thus indicating need for augmenting the runway capacity. Hence, it has been concluded that the airport shall, in minimum, need a parallel set of runways with sufficient lateral spacing to permit their simultaneous independent operation.

Table 18: Number of runways recommended

Development Period	Aircraft Design Peak Hour (ADPH)	Runways
Opening Phase	24	1
Short-Term	39	2
Medium-Term	68	2
Long-Term	91	2

8.3.6.1. Runway length

In determining runway length requirements, take-off is generally the critical operation because a landing aircraft, unless it overshoots the landing area of the runway, can always land in less distance, even on a wet runway, than is required by the same aircraft for take- off.

Runway length requirements are based on a balanced runway concept under which the runway length required is that which is actually needed to achieve take-off speed plus the distance needed to stop if the take-off must be aborted. Under this concept each aircraft manufacturer prepares calculations based on a set of temperatures, pressure altitudes (runway elevation) and other postulations that establish runway take-off requirements.

8.3.7. Taxiways

The runways, passenger and cargo terminals, and aircraft parking and servicing areas are linked by the taxiway system. Therefore, various components of the taxiway systems serve to link the functional units and are an integral part for the overall systems efficient performance.

Planning norms for taxiway system

In planning the general layout of the taxiway system, the following principles have been considered:

- taxiway routes should shortest, thus minimizing both taxiing time and cost;
- taxiway routes should be as simple as possible in order to avoid pilot confusion and the need for complicated instructions;
- Straight runs of pavement should be used wherever possible. Where changes in direction are necessary, curves of adequate radii, as well as fillets or extra taxiway width, should be provided to permit taxiing at the maximum practical speed.
- taxiway crossings of runways and other taxiways should be avoided whenever possible in the interests of safety and to reduce the potential for significant taxiing delays;
- taxiway routings should have as many one-way segments as possible;
- taxiway layouts must be planned to avoid interference with navigation aids by taxiing aircraft;
- the exit taxiway should allow an aircraft to move off the runway without restriction to a point clear off the runway, allowing another operation to take place on the runway as soon as possible;

The taxiway system for the proposed JIA has been designed strictly observing the norms listed above. Physical characteristics of the taxiways and safe separation distances from runway, other taxiway, taxi lanes and objects are as per ICAO recommendations contained in Annex 14 Vol 1, Seventh Edition.

The requirements for JIA are based on the clearances provided for code letter F and instrument runways with code number 4.

Table 19: Taxiway minimum separation distances

Code letter	Distance between taxiway centre line and runway centre line (metres) — Instrument runways Code number 1	2	3	4	Non-instrument runways Code number 1	2	3	4	Taxiway centre line to taxiway centre line (metres)	Taxiway, other than aircraft stand taxilane, centre line to object (metres)	Aircraft stand taxilane centre line to aircraft stand taxilane centre line (metres)	Aircraft stand taxilane centre line to object (metres)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
A	82.5	82.5	–	–	37.5	47.5	–	–	23	15.5	19.5	12
B	87	87	–	–	42	52	–	–	32	20	28.5	16.5
C	–	–	168	–	–	–	93	–	44	26	40.5	22.5
D	–	–	176	176	–	–	101	101	63	37	59.5	33.5
E	–	–	–	182.5	–	–	–	107.5	76	43.5	72.5	40
F	–	–	–	190	–	–	–	115	91	51	87.5	47.5

Note 1.— The separation distances shown in columns (2) to (9) represent ordinary combinations of runways and taxiways. The basis for development of these distances is given in the Aerodrome Design Manual *(Doc 9157), Part 2.*

Note 2.— The distances in columns (2) to (9) do not guarantee sufficient clearance behind a holding aeroplane to permit the passing of another aeroplane on a parallel taxiway. See the Aerodrome Design Manual *(Doc 9157), Part 2.*

From the existing day profile of aircraft movements, it is also observed that particularly during peak hours the ratio of arrivals to departures or vice versa is highly unbalanced resulting in very high demand for departures or arrivals. Further, as and when one of the two runways is under regular maintenance, the other available runway has to cater to both the arrival and departure traffic. As such in view of expected mixed operation of both the runways, two parallel end to end taxiways to serve each of the runways are essential.

A rapid exit taxiway is a taxiway connected to a runway at an acute angle and designed to allow landing airplanes to turn off at higher speeds than those achieved on other exit taxiways, thereby minimizing runway occupancy time. In designing the taxiway system, rapid exits from runway are planned such that the runway occupancy time could be reduced to the minimum. Runway occupancy time (ROT) refer to the time period when one aircraft occupies the runway to the exclusion of all other aircraft. Also affected by the size and weight of the aircraft, it is a combination of either line-up time plus the take-off roll time plus the time required to climb to a specified altitude or heading, or the landing roll time plus some portion of the time the aircraft is on approach (typically that time is also a reflection of the time required for the previous aircraft to cross the threshold and taxi clear of the active runway). It is aimed to have runway occupancy times ranging from 50 to 55 seconds.

The location of the rapid exit taxiways will depend on aircraft operating features as well as other factors such as the optimum traffic movement within the taxiway system, etc. In order to calculate the distance with respect to the threshold at which the rapid exit taxiways must be located, different analytical methods are used.

The number of rapid exits necessary to serve the intent depends on the aircraft mix operating during peak hour. ICAO recommends that a runway has rapid exits when air traffic movements surpass 25 or 30 operations/hour and distance separation between the two rapid exits should vary between 450 m and 600 m. As the aircraft mix may comprise of Turbo-prop, narrow body and wide-body Jets, three rapid exits for each of the runway are planned.

The rapid exits allow lower runway occupation times and they would be located between 1,500 meters and 2,500 meters from the runway threshold, increasing the number of hourly operations in the order of 2-4 more operations per hour, if the runway is being used exclusively for arrivals.

Horonjeff Analytical Method for the Computation of the Runway Rapid Exit Location:

In order to calculate analytically the distance the runway rapid exits should be located in relation to the runway threshold the method described by Robert Horonjeff is used. The rapid exits have an angle of 30 degrees with the runway centerline.

The following table provides the recommended distances from the runway threshold of 1,480 meters, 1,880 meters, and 2,450 meters.

Table 20: Location of rapid exits in relation to the ICAO aircraft category

ICAO Category	Approach Speed (Kt)	Distance from the runway threshold to the rapid exit, in meters
A/B	110	1,238
C	120	1,480
D	135	1,880
E	154	2,450
F	145	2,171

To guarantee maximum runway clearance efficiency for all type of aircraft in all-weather conditions, in order to minimize runway occupancy time, the distances presented in the preceding have been increased by 5%.

Table 21: Number and characteristics of the rapid exits

Angle with runway center-line		**30º**
Number of Rapid Exits per runway		**3**
Distance from threshold	First RET	1,550 m
	Second RET	1,975 m
	Third RET	2,575 m

8.3.8. Holding bays

According to ICAO, the holding bays become necessary when the volume of aircraft operations is higher than 50,000 annual movements. The purposes of providing holding bays are:

- To vary the takeoff clearance,
- To delay the departures of some aircraft due to unexpected circumstances,
- To make technical verifications in the aircraft before takeoff,
- To carry out engine tests in the turboprop aircraft, or
- To verify VOR heading.

As shown in the following table, the positions of the holding bay must be at a sufficient distance from the runway center-line so that the holding aircraft do not interfere with the electronic signal of the radio aids. According to ICAO Annex 14, Table 3-2, the distance from the runway center-line to the aircraft position in a holding bay shall be 107.5 m for code number 4 where the code aircraft is F, but the distance may need to increase to avoid interference with radio navigation aids on critical and sensitive areas of ILS, or to decrease if the holding position is at a lower elevation than the runway threshold.

Table 22: Minimum Clearance Distances in a Holding Bay (F code)

Type of runway	Code number 1	2	3	4
Non-instrument	30 m	40 m	75 m	75 m
Non-precision approach	40 m	40 m	75 m	75 m
Precision approach category I	60 m[b]	60 m[b]	90 m[a,b]	90 m[a,b,c]
Precision approach categories II and III	–	–	90 m[a,b]	90 m[a,b,c]
Take-off runway	30 m	40 m	75 m	75 m

a. If a holding bay, runway-holding position or road-holding position is at a lower elevation compared to the threshold, the distance may be decreased 5 m for every metre the bay or holding position is lower than the threshold, contingent upon not infringing the inner transitional surface.

b. This distance may need to be increased to avoid interference with radio navigation aids, particularly the glide path and localizer facilities. Information on critical and sensitive areas of ILS and MLS is contained in Annex 10, Volume I, Attachments C and G to Part I, respectively (see also 3.11.6).

Note 1.— The distance of 90 m for code number 3 or 4 is based on an aircraft with a tail height of 20 m, a distance from the nose to the highest part of the tail of 52.7 m and a nose height of 10 m holding at an angle of 45° or more with respect to the runway centre line, being clear of the obstacle free zone and not accountable for the calculation of OCA/H.

Note 2.— The distance of 60 m for code number 2 is based on an aircraft with a tail height of 8 m, a distance from the nose to the highest part of the tail of 24.6 m and a nose height of 5.2 m holding at an angle of 45° or more with respect to the runway centre line, being clear of the obstacle free zone.

c. Where the code letter is F, this distance should be 107.5 m.

Note.— The distance of 107.5 m for code number 4 where the code letter is F is based on an aircraft with a tail height of 24 m, a distance from the nose to the highest part of the tail of 62.2 m and a nose height of 10 m holding at an angle of 45° or more with respect to the runway centre line, being clear of the obstacle free zone.

The most convenient location for a holding bay is in the adjacent area to the taxiway that connects to the takeoff runway. ICAO recommends one or more holding bays when the airport handles a high movement of aircraft.

In addition to holding bays to manage take-off sequence, other infrastructure can be used with which an aircraft can pass another one when taxiing towards the runway and, actually, establish the best possible take-off sequence. This other infrastructure includes:

- Double taxiways: By using a second taxiway or a deviation road, the normal taxiway can be avoided. They only allow for a relative take-off priority separating the take-off line into two. A deviation taxiway can be built at a relatively low cost, but if offers scarce flexibility to alter the take-off order.

- Double runway accesses: Use of more than one access to the runway to take off, usually, according to aircraft type and taking-off run requirements Thus, aircraft with shorter taking-off run and which do not need the complete runway can use different accesses located on the end and the time the runway is busy is reduced.

At Jewar Airport, the design of the holding bay in medium to long term will allow for three aircraft lines to enable separation of aircraft according to their wake turbulence and manage take-offs more efficiently.

As the runway is sufficiently long, to reduce the taxi distance and the ROT, three link taxiways are proposed at suitable distances for aircraft requiring shorter take-off.

8.3.9. Aprons

Aprons are among the most active and, at times, congested areas at an airport. Aircraft taxi to and from aprons, while Ground Support Equipment (GSE) used for aircraft servicing, fueling, and cargo and baggage loading and unloading operate in close proximity to aircraft in the apron environment. Additionally, there is potential for aircraft congestion and interaction, particularly at busy airports during periods of concentrated aircraft activity and in physically or operationally constrained areas. In addition to the dynamic aspects of the apron environment, facilities and equipment also influence apron planning and design. This is particularly true where the facility geometry/footprint is unique or constrained and at facilities with significant apron equipment (passenger loading bridges, hydrant fuel pits, and related items).

A proper apron design is critical to the safety and efficiency of aircraft and ground support equipment operations, personnel activities, and passenger movements. Aprons facilitate the on- and off-loading of passengers and cargo, as well as aircraft servicing. Planning and design of aprons needs to consider many factors, including the operational and physical characteristics of the aircraft to be served; the maneuvering, staging, and location of ground support equipment; and the dimensional relationships of parked aircraft relative to the terminal or other facilities.

All apron areas need be appropriately configured and sufficiently delineated to protect the safety of aircraft occupying these areas: to enable personnel and equipment to safely and efficiently move to, from, and among aircraft to service them between operations; and to accommodate the safe, secure, and orderly transfer of passengers, baggage, and cargo among aircraft and facilities. Aprons must also provide sufficient area for the safe and efficient maneuvering of aircraft without significantly affecting adjacent parked aircraft or aircraft taxiing through or near apron areas.

8.3.9.1. Apron types

Several different types of aprons have been developed at airports. The following sections describe the physical apron facilities and identify the activities that occur on each type of apron, which has been accounted for in designing their location and layout.

8.3.9.1.1. Terminal area aprons

The terminal area apron is the interface between the terminal building and the airfield and is one of the most congested and active areas at a commercial service airport. Passengers are enplaned on and deplaned from aircraft while GSE used for aircraft servicing, including catering, fueling, and loading and unloading of baggage and cargo, operates in close proximity. These activities coupled with aircraft taxiing to and from the gates, drive the need for proper apron planning to enhance safety for ramp workers, aircraft operations, ground vehicle operations, and, in some cases, passengers while maximizing the use of available apron area.

There are generally two categories of terminal aircraft parking positions— close-in and remote. Close-in gates consist of contact gates and noncontact gates. Contact gates are those located directly adjacent to a terminal building and passenger loading bridges are used to connect the aircraft to the building. Noncontact gates also have aircraft parking positions sufficiently close to the terminal building to facilitate the use of air stairs (stairs built into the aircraft), ramps, or mobile stairs to enplane and deplane passengers. These are referred to as noncontact gates because there is no direct link between the aircraft and the building. Passengers follow designated walkways to doorways into a terminal or concourse building. Ground loading with noncontact gates is common for regional jet or propeller aircraft serving airports with limited or no passenger loading bridges. Ground loading can also be used for narrow-body or wide-body aircraft.

8.3.9.1.2. Cargo apron

Most airports, ranging from large hub to general aviation airports, have infrastructure to accommodate air cargo operations. The type of cargo facilities at an airport is largely dependent on the type and frequency of cargo airline service, which in-turn is largely driven by factors external to the airport, such as geographic location, competing airports, the availability of other modes of cargo transport (e.g., rail), supporting transportation networks (highways and railways), and the presence of businesses and industries that drive demand for cargo services. By air the cargo is transported as belly cargo or through a freighter as all cargo service.

Belly Cargo:

While the primary function of the passenger airlines is the transportation of passengers, most airlines use the lower aircraft deck for transporting passenger baggage and cargo. Belly cargo, defined as that transported in the belly compartments of passenger aircraft, is typically processed and sorted at cargo facilities located away from the terminal gates, but with vehicle access to landside and airside facilities. Belly cargo is transported to the terminal apron, where it is loaded onto aircraft parked at the gate(s). Depending on the size or configuration of the aircraft, cargo may be containerized prior to loading onto the aircraft. Container loaders consist of lifts with ball bearings that raise containers level with the

aircraft door sill so that containers can be easily rolled into the aircraft. Cargo that is not containerized is loaded and secured within the aircraft similar to passenger baggage. Belly cargo can introduce additional vehicles into the apron area as cargo is brought to departing aircraft and picked up from arriving aircraft.

All Cargo:

All-cargo airlines transport only cargo and are either dedicated to transporting cargo or a division of a passenger airline that transports cargo. Aprons for all-cargo aircraft are usually separated from terminal aprons. This is largely due to the landside access and vehicle maneuvering and parking areas needed to accommodate large cargo delivery/transfer vehicles and, in some cases, large numbers of vehicles at peak times (e.g., to support overnight delivery operations). Placement of all-cargo aircraft facilities away from terminal facilities reduces cargo vehicle interactions with passenger-related traffic and allows for better utilization of terminal area aprons required to efficiently accommodate passenger activity that requires proximity to the terminal building. Furthermore, the type and quantity of GSE used to service all cargo aircraft and the facilities that support all-cargo aircraft operations are substantially different from passenger terminal facilities and are usually best located in a designated cargo area.

Cargo operators use a variety of aircraft types to serve individual markets. The size of all-cargo aircraft serving an airport is largely driven by cargo demand in the local service area, as well as larger cargo collection/distribution networks. Large wide-body aircraft typically serve international cargo markets, larger cities, and cargo operator hubs, while narrow-body aircraft serve smaller domestic cargo operations. Turboprop aircraft are also used to transport time-sensitive cargo to smaller communities.

8.3.9.1.3. Maintenance apron

Aircraft maintenance activities include inspections that must be completed on demand or at specific intervals of aircraft operation, such as hours flown or numbers of takeoffs and landings (cycles). Each airline is required to prepare an aircraft maintenance program that outlines the activities to be performed during each inspection. Aircraft maintenance facilities, generally consisting of hangar buildings sufficiently sized to accommodate the aircraft fleet, are critical to ensuring that aircraft are adequately maintained and safe for flight. Aircraft maintenance facilities vary among airports and include those serving general aviation aircraft, cargo and passenger airline aircraft, and large maintenance, repair, and overhaul (MRO) operations.

Maintenance aprons are typically located adjacent to these hangar buildings and are used for performing light maintenance or for aircraft storage and staging. Maintenance aprons are also used for staging maintenance equipment. Some maintenance aprons incorporate run-up areas with blast fences to deflect jet blast, propeller wash, and noise when performing engine run-ups.

8.3.9.1.4. Remote apron

Remote aprons are located away from terminal or cargo areas and used for storage or staging of aircraft. Most passenger aircraft do not operate overnight and remain parked at the airport overnight. At airports where the number of aircraft parked overnight exceeds the number of terminal parking positions/gates, remote aprons are used to store aircraft overnight. Remote aprons can also be used to accommodate aircraft in the daytime during extended layovers to allow the use of gates that would otherwise be occupied by aircraft during these extended periods. These aprons can also be used for light aircraft maintenance and servicing during the day.

8.3.9.1.5. General aviation apron

General aviation is defined as all aviation other than military and commercial airline operations. This category of aviation encompasses private pilots flying ultralight and single-engine aircraft, corporate jet flights, air ambulance activity, forest fire fighting operations, air charters, agriculture spraying, and narrow-body and wide-body aircraft transporting sports teams, race horses or other critical wildlife, or dignitaries. General aviation facilities vary in size and configuration, ranging from facilities at airports that accommodate only small piston aircraft to facilities at larger airports that accommodate wide-body jets.

8.3.9.1.6. Commercial aircraft parking /apron size:

1. Gate Stands / Remote Stands

As per the planning criteria and service level requirements, the minimum number of gate/contact stands is proposed to be 80% of the total amount of required stands at Jewar Airport.

2. Number of Aircraft Parking Stands

For the determination of the apron requirements in the different planning periods of the study the aircraft peak hour is taken as a variable.

The necessary number of parking positions is obtained applying the following equation:

$$P = (APH_{arrivals} \times T)/U$$

Where:

- P is the number of aircraft positions.
- APH is the number of peak hour aircraft movements.
- T is the average time of occupation of the positions.
- U is a factor of gate performance

As the parking positions are not occupied immediately after being abandoned by the aircraft parked previously, a gate utilization factor (U) should be estimated using the following expression:

$$U = \frac{\sum A_i \cdot T_i}{P \times H}$$

Where:

A_i, is the number of aircraft by type during the period of time analyzed.

T_i, is the average of occupancy time by each position and by aircraft type.

H, is the number of hours of the period of time analyzed.

P, is the number of aircraft parking positions.

The average time of occupation of the positions (T) is estimated considering the proportion of aircraft of each type operating during the peak hour (M_i) and the average time of parking of each type of aircraft (T_i).

$$\mathbf{T = \sum_i T_i \cdot M_i}$$

The value of M_i varies accordingly to the aircraft movement forecast for each horizon of development. For this calculation of the commercial aircraft apron capacity, the value of U-factor is taken as 60% because it is the most usual value registered at the airports as the average occupancy time during the hours that an aircraft has occupied a position during the peak month and represents a good level of service.

There are positions in the apron which are used by a higher number of aircraft throughout the day due to their location and their position with respect to the terminal building, because they are more easily accessible, and the time while an aircraft leaves these positions and another aircraft arrives are less than in other positions. Therefore, these positions are more efficient and more representative for the capacity since they are occupied most of the period of the day of higher activity in the apron.

Apart from the values obtained from the analytical methods widely used in planning, other results have been included for the traffic horizons, as the ones derived from the airport benchmarking analysis. The number of annual passengers per gate shows another operational indicator of the productivity of the airport. It is related to the daily operational efficiency of the apron and benchmark the turnaround times of the aircraft.

The average number of annual passengers per gate is approximately 500,000 passengers per gate based on the sample of analyzed worldwide airports

These values may be altered in later stages of the Jewar Airport design, once there is more information, such as the daily profiles of aircraft operating on a regular day.

8.3.9.1.7. Apron area requirements

The surface requirements for the passenger apron are determined from the total number of aircraft stands and the aircraft mix (presented in the following table).

Table 23: Number of Passenger Aircraft Positions per ICAO Aircraft Code

Development Phase	ICAO Aircraft Code			
	C	D	E	F
Opening	24	0	1	0
Short-Term	50	0	2	0
Medium-Term	77	0	6	2
Long-Term	101	0	16	4

Using *Table 24*, which shows the space requirements per stand, the apron area requirements are computed in *Table 25*.

Table 24: Required Apron Surface per ICAO Aircraft Code

ICAO Code	Area by ICAO Aircraft Code (Ha)
C	0.41
D	0.75
E	1.14
F	1.50

Source: Airport Development Reference Manual, 10th edition; IATA, March 2014.

Table 25: Apron Surface Requirements

Development Period	Apron Area Requirement Range (m^2)
Opening	146,300
Short-Term	308,100
Medium-Term	488,000
Long-Term	738,600

These values will be increased in the final design since the necessary apron taxiways; space for handling equipment and the final terminal building design will be included.

8.4. Passenger terminal development

Four passengers terminals have been proposed to be developed, one in each phase of Jewar Airport's planned development between the two parallel runways, with access from western side of airport. The

decision for this multi-terminal approach is to allow phased implementation and expansion as demand increases while minimizing passenger walking distances and impact on existing operations. The terminals are configured in a 'swing' configuration to ensure flexibility and allow either domestic or international flow separation without requiring fully redundant arrivals and departures circulation.

The forecourt area of each of the terminals shall provide landside access to all the terminals and shall have main airport access road, parking and all associated landside facilities. The proposed Draft Master Plan for Jewar Airport also safeguards land area for possible future terminal and airside extension. Terminal building development includes:

- Domestic and international passenger processing facilities
- Airside concourses
- Access road network and car parking
- Public transport facilities (metro, bus, and taxi parking)
- Various support facilities related to terminal development

8.4.1. Terminal planning approach

The four terminal buildings are planned according to the following broad objectives:

- Clear, efficient layout to support airline operations and passenger ease of use
- Economical, modular approach to the building floor plan
- Multi-level terminal buildings with separate Departures and Arrivals levels;
- Phase-able approach to support the expansion of a multi-terminal 'campus' with minimum impact to on-going operations
- Energy-efficient terminals
- Minimize passenger walking distances
- Coherent airport 'campus' that promotes a sense of order and well-being

In general, the terminals will have the following characteristics:

- Capability for integrated terminal with Domestic and International operations
- Multi-level curb frontages, departing and arriving on separate levels, with Ground Transport functions in the center of the Forecourt

- Swing and common use facilities where feasible and not requiring fully redundant arrivals and departures circulation
- Easy and intuitive way finding achieved through visual connections and straight-forward layouts
- Economical and modular approach to building services and systems

To maximize the use of space the terminals are planned to accommodate modern operating practices and processes and to leverage maximum benefit from the latest passenger processing technology. Accordingly, the terminals will have:

- Shared concourses linking terminals via passengers walkways
- Shared gate-lounges
- Common check in environment
- Passenger self service facilities
- Efficient BHS system
- Shared support and welfare facilities

These features should help promote efficient passenger handling processes and contribute in providing a value for money for airlines and passengers alike. Together these objectives and characteristics would serve to deliver the Subjective Quality of Service Parameters.

8.4.2. Assumption and planning criteria

Terminal facility requirements have been developed with consideration to the following:

- Annual and peak hour forecasts for the Base Case forecasts with consideration to planning activity levels to establish terminal phasing
- IATA Airport Development Reference Manual (ADRM), 10th edition, 4th release Oct 2016, Where no IATA ADRM 10th edition guidance was available for facility programming, the 9th edition was utilized, as applicable. For all other non-IATA covered areas and processors, approaches and calculations are based on benchmarking of comparable airports
- Passenger and airline operating characteristics based on benchmarking from similar Indian airports with similar passenger, aircraft, and cargo movement characteristics as the Jewar Airport is a green field airport and historical data is not available.

In addition, the minimum requirements / parameters for the development of the airport are as follows:

- IATA Level of Service C (Optimum Standards) compliant;
- 80 percent of each of the international and domestic aircraft gates shall be served by the boarding bridges, if desired by airlines;
- Unit area of the terminal building including all miscellaneous and support spaces per peak hour passenger (including arrival and departure), shall be minimum 30 square meters;
- Commercial area of 1000Sq Mt per million per year of passengers capacity.
- Provide international standard range of retail and other passenger services; and
- Terminal design capable of incremental expansion with minimal impact on existing operations.

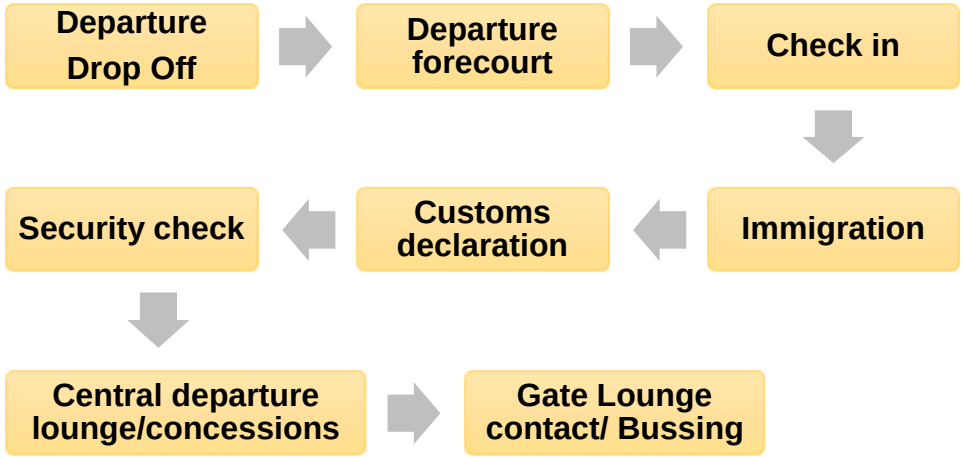
8.4.3. Terminal flows

All facilities that process passengers and their baggage, public amenities, and spaces needed to effectively operate the building—the relationships among these facilities are discussed in this section based on operational standards at Indian airports with specific reference to procedures followed by the following agencies:

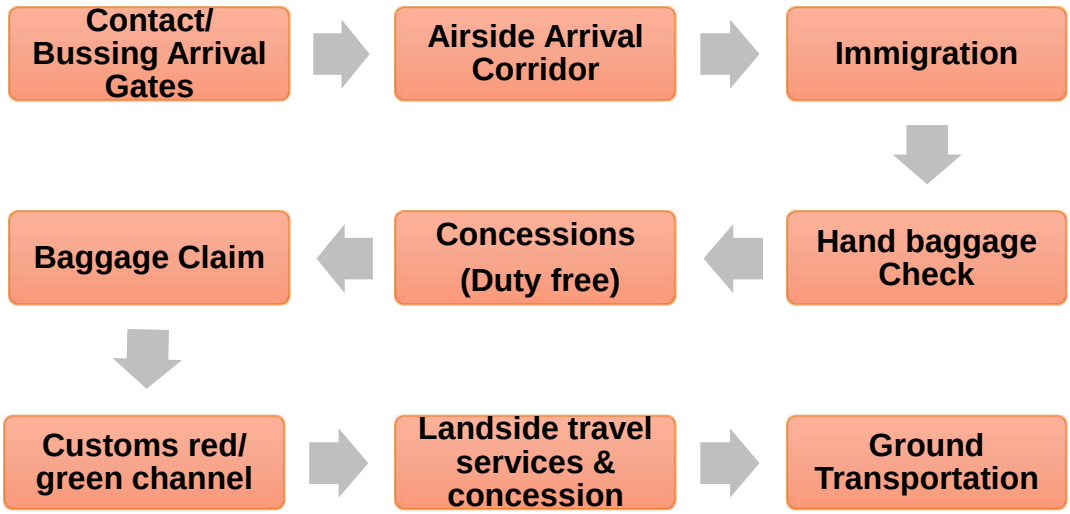
- Ministry of Civil Aviation (MoCA);
- Directorate General of Civil Aviation (DGCA);
- Central Board of Excise and Customs;
- Bureau of Immigration;
- Bureau of Civil Aviation Security (BCAS); and
- Central Industrial Security Force (CISF).

Passenger Flow Process:

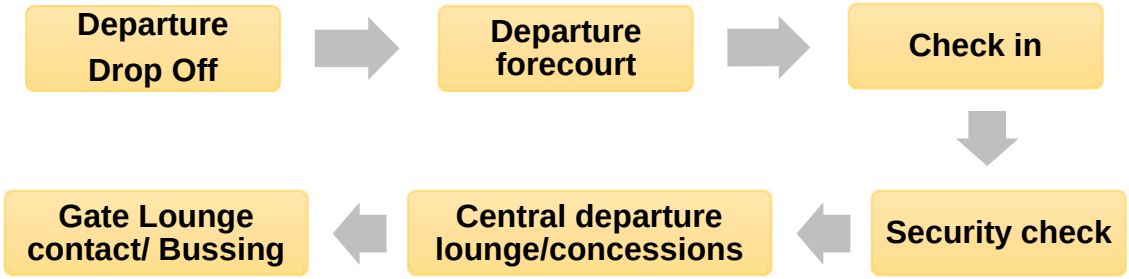
- **International Departures**



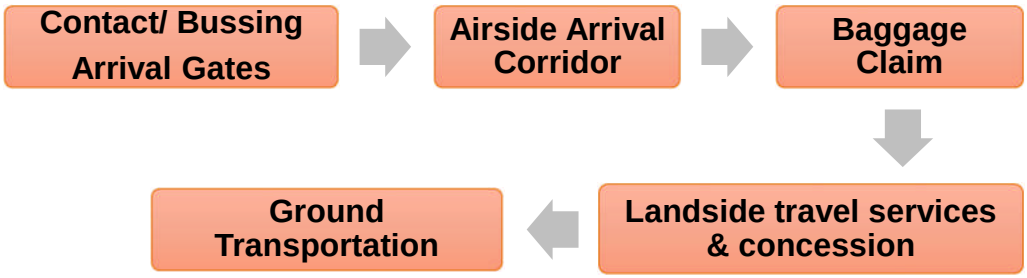
International Arrivals



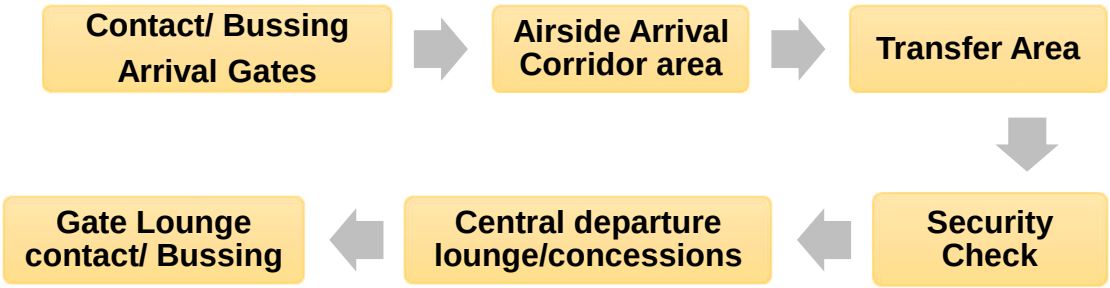
- **Domestic Departures**



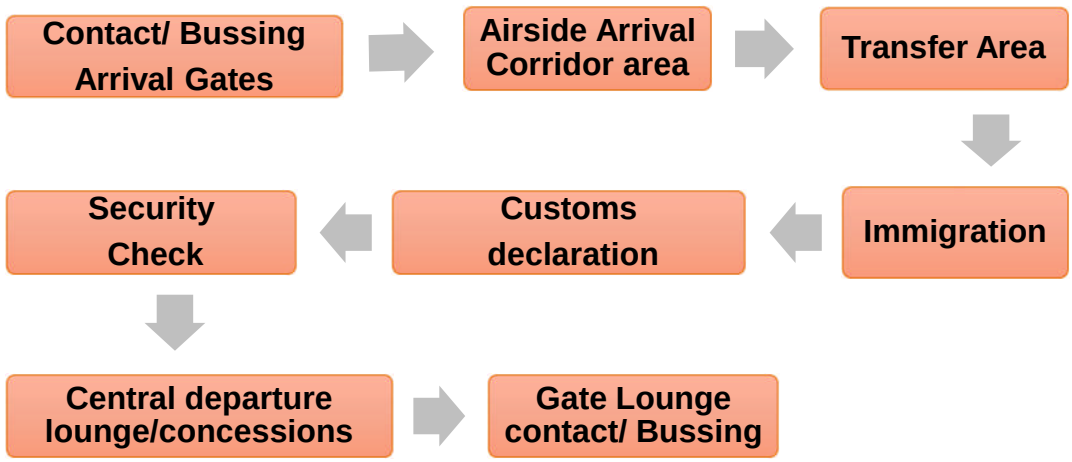
- **Domestic Arrivals**



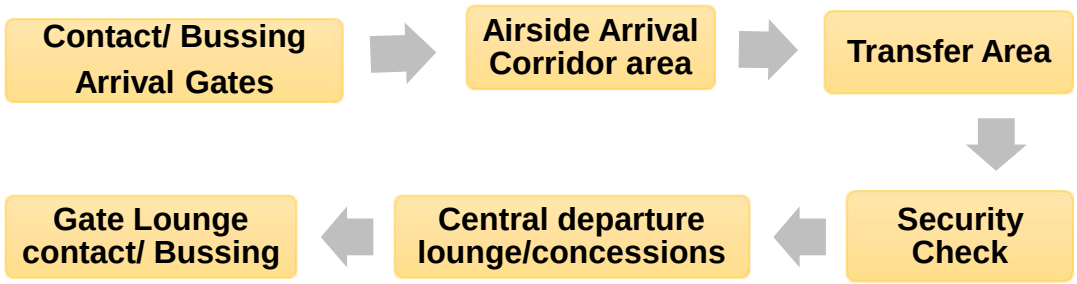
- **Domestic – Domestic Transfers**



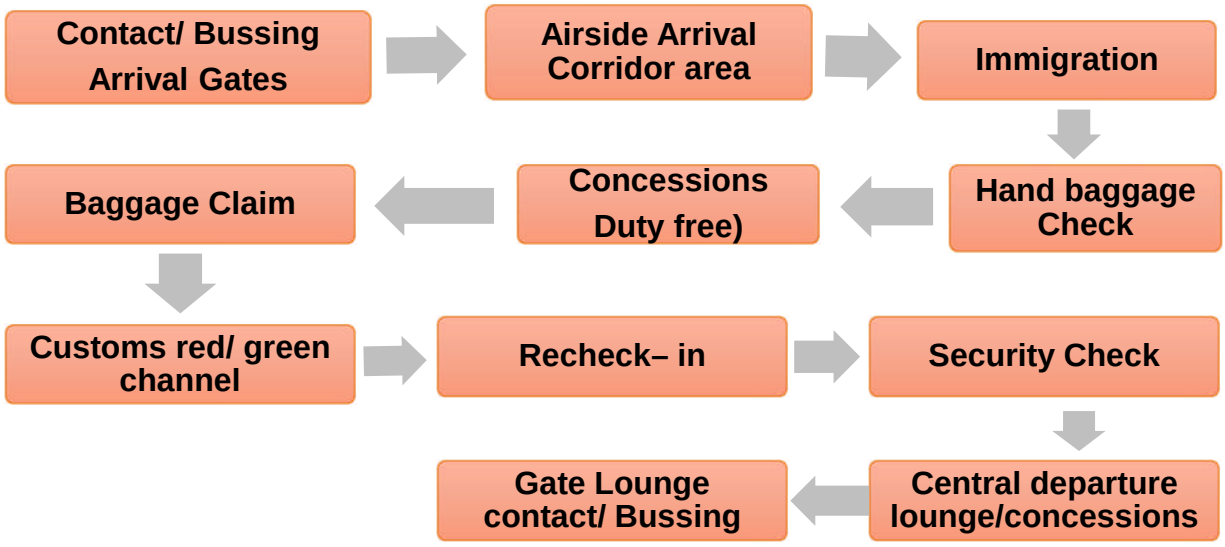
- **Domestic – International Transfers**



- **International– International Transfers**



- **International – Domestic Transfers**



8.4.4. Terminal phasing

The indicative phasing by capacity and type of activity is presented in the following table.

Table 26: Indicative phasing, by capacity

Terminal	Phase	Capacity (million passengers per annum)	Cumulative Capacity (million passengers per annum)
Terminal 1	Opening Phase	12 MPPA	12 MPPA
Terminal 2	Short Term	18 MPPA	30 MPPA
Terminal 3	Medium Term	20 MPPA	50 MPPA
Terminal 4	Long Term	20 MPPA	70 MPPA

8.4.5. Passenger terminal surface area requirements

The program for the Facility Requirements of the passenger terminal building can be drawn from the IATA published methodologies. Within the Passenger Terminal Building several independent functions require spatial analysis to accommodate the Peak Hour Demand.

Processing Areas Assumptions

In accordance with service standards and essential facilities proposed to be provided for meeting the traveler's needs initially a number of assumptions for the processing needs must be established, as outlined in the following table.

Table 27: Processing area assumptions

International Departures Process	
Number of Well-Wishers per Pax	Not allowed inside Passenger Terminal
Check-in Processing Time	3 mins. - Maximum Queuing Time 30 mins.
Exit Passport Control Processing Time	60 secs.
Airside Security Screening	25 secs.
Gate Hold Room Occupancy	80% Load Factor - 80% seated pax - 20% standing pax
International Arrivals Process	
Arrivals Passport control	60 secs.
Baggage Claim Occupancy - Narrow Body	20 mins.
Baggage Claim Occupancy - Wide Body	45 mins.

Baggage Claim Occupancy - Cat F	60 mins.
Customs Control Processing time - Red Lane	10 min – 10%
Customs Control Processing time - Green Lane	15 sec - 90% pax
Number of Meters & Greeters per Pax	Not allowed inside Passenger Terminal
Domestic Departures Process	
Number of Well-Wishers per Pax	Not allowed inside Passenger Terminal
Check-in Processing Time	2 mins. - Maximum Queuing Time 20 mins.
Airside Security Screening	25 secs.
Gate Hold Room Occupancy	80% Load Factor - 80% seated passenger - 20% standing passenger
Domestic Arrivals Process	
Baggage Claim Occupancy - Narrow Body	20 mins.
Baggage Claim Occupancy - Wide Body	45 mins.
Number of Meters & Greeters per Pax	Not allowed inside Passenger Terminal

Terminal space

Terminal space requirement has been calculated based on the peak passenger forecast of the design year. Recommendations of IMG, reproduced in the following table, too have been taken into considerations.

Table 28: IMG norms

IMG NORMS	Area in square meter. of terminal building per PHP
AREA per passenger	
Domestic	22-23
International	27-28
integrated	24-25

Special considerations have been given to the fact that the airport location is prone to extreme weather conditions. Poor visibility in winters, extreme temperatures, thunderstorms and dust-storms in summers, fog, smog etc. are frequently encountered leading to delays, and prolonged turnaround time. Such delays lead to additional dwell time for the passengers in the terminal building. As such an additional space of 15% only is considered to ensure that during such delays, the service level is maintained, and comfort to the passengers is not compromised.

Further, the recent development in passengers processing like Visa-on-Arrival, and requirements of transit passengers in medium and long term, have also been taken in account in calculating the terminal space requirements.

The following table provides the terminal space planned to be provided in different phases:

Table 29: Terminal space requirement

Phase	Capacity (million passengers per annum)	Cumulative Capacity MPPA)	Peak hour passenger	Terminal space in Sq. Mt
Opening Phase	12 MPPA	12 MPPA	2750	90,000
Short Term	18 MPPA	30 MPPA	5500	90,000
Medium Term	20 MPPA	50 MPPA	9000	1,60,000
Long Term	20 MPPA	70 MPPA	13000	1,60,000

Building management system, CCTV surveillance, Security and access control shall be integral part of the Terminal design.

8.5. Air cargo development

Air Cargo Facility has been planned as part of master plan of Jewar Airport, to be located on the eastern side of the airport with both landside and airside access.

The proposed location shall enable a separate access to segregate cargo traffic, such as heavy trucks, from the passenger traffic on main access road on the west. The proposed Jewar Airport's air cargo facility shall have all cargo operations, including:

- International cargo- import, export, transit
- Domestic cargo
- Express / courier cargo
- Perishable cargo
- Air mail
- Valuable cargo
- Cold storage
- Hazardous cargo

8.5.1. Planning approach

The proposed air cargo facility of Jewar Airport shall have international cargo and domestic cargo operations as part of a single integrated cargo complex. Jewar Airport's air cargo shall have both belly cargo and freighter cargo for its domestic and international cargo business, based on the cargo traffic forecast. Accordingly, air cargo facility of Jewar Airport has been planned with required apron areas

and aircraft stands for cargo freighters, space for cargo buildings, warehouses and landside access suitable to facilitate in-bound and out-bound movement of cargo materials, equipment, employees, and users of cargo facility. Proposed air cargo facility shall be developed in phases to meet demand. To facilitate long-term development, the cargo complex at Jewar Airport have been planned with all required infrastructure elements and ancillary facilities including access roads, truck staging areas, truck loading docks, cargo operational facilities and warehouses for international cargo- import, export, transit cargo, domestic cargo, express / courier cargo, perishable cargo, air mail, hazardous cargo, etc. along with cold storage, inspection facilities, cargo offices, custom offices, banks, airline offices etc. The proposed cargo complex facilities shall be of flexible and modular design that is replicable, thus enabling the facilities to be adapted to the needs of the users, and expanded as required in line with growth in cargo volumes.

Cargo storage areas are a part of the Security Restricted Area (SRA). At Jewar Airport, security controls will be applied to cargo and mail, prior to being loaded onto an aircraft. The cargo and mail will be protected from unauthorized interference from the point that security controls are applied until the departure of the aircraft.

8.5.2. Air cargo facility requirements

The proposed air cargo facility of Jewar Airport has been sized appropriately based on cargo traffic forecast for each phase of development, and the processing efficiency has been assumed to be 15 ton/square meter –year. From the outset, 10% of the annual forecast tonnage is expected to be perishable. This assumption has been based upon benchmarking against both Indian airports and international airports of a similar scale. In the final phase, the cargo processing terminal reaches a size of 150,000 square meters. The facility will also accommodate appropriate offices and the Animal/Plant Quarantine Station.

The airside circulation area has been planned to contain adequate storage and maneuvering space for vehicles with cargo dollies carrying unit loading devices to transfer freight between the cargo facility and other areas of the airport. As majority of cargo tonnage is expected to be belly hold, an airside road/passage system will be in place to ensure connectivity between the cargo facility and passenger aircraft aprons.

In the final phase, the cargo apron will have ten dedicated aircraft stands, all capable of handling Code F aircraft. Five of the cargo stands have been designed as nose-loader stands. The numbers of stands have been calculated on the basis of the cargo forecasts and dwell times of dedicated cargo aircraft at Jewar Airport. As the cargo forecast shows further continued growth of traffic, the Master Plan is prepared to cater for the further growth by earmarking an area of 60Ha of area for the cargo village. In addition, for future development of Cargo Area on Apron side, provision exists for expansion to accommodate 15 freighter aircraft simultaneously.

Planning Assumptions

Cargo processing capacity of 15 ton/ square meter- year

10% of the annual forecast tonnage being perishable;

Cargo stand occupancy time of 180 minutes;

Nominal building depth of 85 meters

Landside circulation zone of 34 meters for parking, loading roads along with 5% contingency;

Airside circulation zone of 18 meters for storage and loading along with 5% contingency;

Code E/F aircraft shall be operated for International cargo;

Cargo space requirements

Based on planning norms stated above, required space in cargo terminal has been calculated and tabulated as follows:

Table 30: Cargo warehouse requirement

Name	Year	Cargo (in metric ton)	Space (in sq. m)
Opening	2022-2028	0.75	50000
Short Time	2028-2034	1.05	70000
Medium term	2034-2039	1.5	100000
Long Term	2039-2044	2.0	150000

Table 31: Cargo apron requirement

Name	Year	Cargo (in metric ton)	Bays Required
Opening	2022-2028	0.75	4
Short Time	2028-2034	1.05	6
Medium term	2034-2039	1.5	8
Long Term	2039-2044	2.0	10

8.6. Air Traffic Control Tower

The Air Traffic Control Tower (ATCT) is responsible for monitoring the movement of aircraft and vehicles on the airfield movement area of the airport, as well as all air traffic within 5 nautical miles

(NM) around and up to 3,000 to 5,000 feet above the airport. Movement areas include runways, taxiways, and taxi lanes. The ATCT tower has been proposed at a central location between the both parallel runways which provides a high level of security and maximizes visibility of runway thresholds and runway approaches. The height of the tower is anticipated to be up to ~ 75 meters, subject to detailed siting and design studies. A site area of 0.3 ha has been proposed for the said facility at the airport. In addition to ATCT, although the details about the air traffic control services have not yet been evolved, another site with a total area of 1.0 Ha has been proposed in landside areas of Jewar Airport for construction of an integrated block to serve ATC/MET/ BCAS/BDDS/DGCA requirements.

8.6.1. Aerodrome ground lighting

Aerodrome Ground Lighting (AGL) will be installed in accordance with the relevant standards and aerodrome reference code. AGL is planned to be powered via two substations and Constant Current Regulators (CCRs). This will be developed at the time of runway construction. For Phase I the first AGL substation is planned in an airside location on the eastern part of the airport site and south of southern runway. When the second runway is constructed a second AGL substation is planned to be constructed in an airside location on the eastern part of the site, north of northern runway.

The typical components of Airfield Lighting CAT I/III proposed to be part of the JIA, are the following systems:

- Approach Lighting Systems
- PAPIs (Precision Approach Path Indicators)
- Threshold Lights
- Runway Edge Lights
- Runway End lights
- Runway Centreline Lights
- Taxiway Edge Lights
- Taxiway Centre-line Lights
- Holding Position Lights
- Stop Bars
- Apron Floodlights
- Lighted Wind Direction Indicators (Wind Cones)

- Lighted Guidance Signs

8.7. Airside roads

An airside road system that ensures efficient connectivity between aprons, and other airside facilities and areas is planned. This includes a planned underground passage that connects the terminals to the eastern part of the airport site, under the cross-field taxiways, facilitating fast and efficient travel between these areas while reducing surface congestion. Connectivity at the second basement level is also envisaged between different terminals for efficient operations.

A perimeter road 7mt wide, duly lighted, has been planned all along the operational boundary wall to ensure day and night peripheral security. Service roads to access all the facilities and airside installation is planned utilizing the perimeter road.

8.8. Operational walls

Operational wall including airside segregation from landside is planned to be provided in accordance with DGCA and Bureau of Civil Aviation Security (BCAS). Perimeter fencing, wherever needed, will be installed as Part of Phase I, and will be expanded to ensure that the security guidelines are met in all Phases of airport developments as demand increases.

8.9. Airside access gate

Access gates to facilitate the movement of people, vehicles and other equipment or goods between landside and airside, will be strategically placed to ensure efficiency of movements and will operate in accordance with the relevant security regulations. Development of access gates will be phased as the airfield is expanded.

8.10. Isolation bay

An isolation bay/area is an area for the parking of an aircraft which is known, or believed, to be the subject of unlawful interference, or which for other reasons needs isolation from normal aerodrome activities. An isolation bay/area of 1.6 Ha has been provided in accordance with the relevant DGCA requirements.

It is proposed to develop the isolation bay/area in the opening phase of the project.

8.11. Bomb cooling pit

A bomb cooling pit, an essential requirement, for the isolation and disposal of potential explosives is planned to be provided in the southern part of the airport site with appropriate clearances. The bomb cooling pit is planned to be developed as part of Phase I.

8.12. Drainage

As per drainage plan received from YEIDA, it has been noticed that adequate capacity including and covering the airport area, is being created in the drains of peripheral planned roads and the same is expected to be available by the time the airport develops. Drainage infrastructure in air side and city side is planned such that the same is connected to peripheral drainage system as planned by YEIDA.

A well-designed airport drainage system is a prime requisite for operational safety and efficiency as well as pavement durability. Inadequate drainage facilities may result in costly damage due to flooding as well as constituting a source of serious hazards to air traffic. Furthermore, inadequate drainage systems may cause unsightly erosion of slopes and saturated and weakened pavement foundations etc.

In many respects, the design of an airport drainage system is similar to street and highway drainage design. However, airports often have special drainage problems and challenges. Characterized by vast expanses of relatively flat areas and a critical need for the prompt removal of surface and subsurface water, airports usually require an integrated drainage system. Such a system must provide for the removal of surface water from runways, taxiways, aprons, automobile parking lots, and access roads. The runoff then must be removed from the airport by means of surface ditches, inlets, and an underground storm drainage system.

Estimation of runoff, Design of a basic system for collection and disposal of runoff, provision for adequate subsurface drainage are the important parameter to design of airport drainage system. The selection of the severity of the storm which the drainage system should accommodate is an economic consideration. Designing for an extremely severe storm (100-year return) will result in large drainage structures which may not be economically justified. The FAA recommends that, for civil airports, the drainage system be designed for a storm whose probability of occurrence is once in 50 years. This recommendation is adopted for the preliminary design.

Jewar airport is more or less flat. In order to secure drainage slope, the airport area need to be divide in to four parts. The airport will slope downward longitudinally east and west and transversally toward north and south from the center. Two longitudinal drains shall run on either side of runway at the edge of runway strip on either side to drain off runway and taxiway. Two more longitudinal drains shall run on either side on the edge of apron to drain of apron area. Besides this number of local area drains for roads, commercial area, cargo area would be required for draining the respective area. The discharge from these will be suitably laid to drainage network of YEIDA area or to the nearest distributaries/canal present on either side of airport.

8.13. Landside development

Landside development of Jewar Airport is planned towards western part of the airport, close to the airport access roads. The land side areas of Jewar Airport also includes terminal forecourt area with terminal access roadway system, metro station and all the landside facilities like multi-level car parking (MLCP), terminal utilities plant, airport management offices, airlines offices, other related offices and facilities, reserved services, police station, etc. along with bus, taxi, car parking staging areas have been proposed as part of landside area of Jewar Airport. The land side area of the eastern part shall include utility plants, truck parking, bus parking, car parking along with cargo offices and landside facilities for various stakeholders. The airport access roads on the western and eastern part of the airport are essential part of landside plans of Jewar Airport.

Landside area of Jewar Airport shall also include land reserved for future landside requirements and shall be developed for allied activities/ services related to airport development. The proposed uses may include such uses, necessary and permissible for holistic development of a world class airport, read with National Civil Aviation Policy 2016 of Ministry of Civil Aviation, Government of India.

The proposed landside development of Jewar Airport includes traffic and transportation system with all roadways; parkings and metro connectivity requirements of Jewar Airport; along with landside uses, facilities and infrastructure, to meet the needs for an airport. The Master Plan provides external access to Jewar Airport, from both east and west, with road and metro. The proposed master plan maintains the requirement of two access routes into the airport from west and east, but eliminates through traffic and segregates passenger traffic and cargo traffic. This also avoids the security risks associated with public traffic through operational airport. The central airport access road leads to the terminal forecourts which consists of terminal access roads, curbs, parking areas, public transport, and future metro station, pick up and drop off curbs, terminal landside facilities, etc. The terminal forecourt area provides an integrated multi modal access to airport which prioritizes public transport and provides customers with modal choice.

Based on current information, it is expected that metro access would be available to the airport from Greater Noida on the western side of the airport. A definite plan is not yet known, but it is understood that YEIDA has taken up the project with concerned authorities and in – principle approval may be received shortly. However, as timelines of Metro connectivity and the details of proposed metro connectivity to terminals are not yet known, a 20 meter wide corridor running through the center of the approach roads to the terminal has been included in the master plan.

The proposed internal traffic and transportation network of Jewar Airport is based on traffic travel characteristics of large global and Indian airports, including IGIA. This includes assumptions on behavioral aspects of traffic such as peak/daily traffic levels, modal splits of airport traffic, vehicle

occupancy levels, and dwell times at curb etc. The traffic on main access road, terminal and curb roads is estimated for all the phases based on correlation to the overall airport traffic forecasts. The road network for Jewar Airport shall be developed in phases as per traffic demand emerging from Terminals, Cargo, City side development, supporting facilities, etc.

The objectives of the landside access strategy are to:

- Provide safe, fast and efficient access for all landside traffic streams;
- Provide competent way finding;
- Minimize or eliminate vehicular traffic conflicts;
- Optimize the utilization of proposed facilities;
- Segregation of vehicular traffic of passengers, cargo and supporting facilities; and
- Promote public transport.

The landside access strategy is integrated with multimodal solution that is phased to meet demand and aligned with airport development and external connectivity planning.

8.14. Proposed external connectivity

YEIDA has provided a network of existing and proposed road connectivity projects around the site. The proposed airport at Jewar is being developed to cater to at least 70 million passengers per annum, which is expected to generate considerable landside traffic volume. Road access alone would not be able to serve the airport and hence strong mutli-modal transport connectivity is required to provide sustainable access in the long term.

Expansion/construction of new roads, external to the airport, that will provide connectivity to the proposed airport, are to be completed by YEIDA and other relevant agencies as per the airport development schedule. However, prior to Phase I and commencement of operations, following enhancements in addition to existing external connectivity to Jewar Airport, are required:

- Provision of an interchange with access control to Yamuna Expressway,
- Provision of at least 4 lane connectivity from the Service Road running alongside the Yamuna Expressway expandable in phases to 12 lanes,
- Connectivity with proposed 130 meter road to Noida via Greater Noida close to the northern boundary for the Cargo Village.

- Providing access to the Airport General Aviation Zone from the 90mt planned road north of the airport at the designated location shown in the masterplan.
- Required interchanges and level-grade separators.

8.15. Landside traffic forecast

Preliminary vehicular traffic demand assessment for Jewar Airport based on overall airport-wide vehicular traffic volumes, including passenger traffic, cargo traffic, employees traffic etc. along with characteristics and behavior, peak/daily traffic levels, modal splits of airport traffic, vehicle occupancy levels, and dwell times at curb areas as benchmarked, has been indicated in this section. Similarly, cargo traffic has also been assessed based on cargo traffic forecast and the assumptions of freight share, average tonnage carried by each vehicle and likely peak hour traffic.

8.15.1. Daily traffic

Based on the mentioned assumptions and parameters, the landside traffic has been estimated for different phases of terminal development at each of the proposed terminals. The estimated includes the daily average passengers and employees at each terminal.

8.15.2. Passenger traffic parameters

The adopted parameters for employee/visitor estimation are presented in the following table. These parameters have been considered as observed from the green field airports for Indian conditions. The person trips estimated with these parameters are converted into landside traffic using modal splits and average occupancy of vehicles.

Table 32: Adopted parameters for employee/visitor estimation

Particulars	Domestic		International	
	Arrival	Departure	Arrival	Departure
Terminal staff/passenger ratio	0.16	0.16	0.16	0.16
Meeter/Greeter ratio	0.20	0.21	0.30	0.45
Driver/passenger ratio	0.25	0.25	0.25	0.25
Driver-Visitor/employee ratio	0.10	0.10	0.10	0.10

Keeping in view of the proposed future airport metro access, the modal split assumes availability of metro in later stages of Jewar Airport development, and accordingly future traffic is estimated. The adopted modal splits for domestic, international passengers and employees (without metro in Phase I) and with metro beyond 25 MPPA have been assessed. The average occupancies are assumed to be constant for all phases.

Passenger Car Units (PCUs) for vehicles and Design Service Volumes (DSV) for lanes requirement are taken from IRC 106. The adopted PCUs are 0.5 for two-wheeler, 1.0 for car/taxis, 1.4 mini bus and 2.2 for standard bus. The capacities are estimated from DSVs and the estimated capacities used for analysis are:

- Main Access Road – 1250 PCUs per lane
- Terminal Access Roads – 1000 PCUs per lane

Table 33: Modal split (%) for person trips – passengers/escorts (domestic)

Vehicle type	Modal split (%)	
	Phase I	Final phase
Two-wheeler	2	2
Auto	15	8
Car (small)	22	15
Car (utility)	8	6
Taxi (small)	27	23
Taxi (utility)	8	6
Mini bus	5	4
Stand. bus	13	11
Rail/metro	0	25
Total	100	100

Table 34: Modal split (%) for person trips – passengers/escorts (international)

Vehicle Type	**Modal split (%)**	
	Phase I	**Final phase**
Two-wheeler	0	0
Auto	5	5
Car (small)	30	23
Car (utility)	5	5
Taxi (small)	37	35
Taxi (utility)	8	6
Mini bus	5	3
Stand. bus	10	8
Rail/metro	0	15
Total	100	100

Table 35: Modal split (%) for person trips – employees

Vehicle type	Modal split (%)	
	Phase I	Final phase
Two-wheeler	30	15
Auto	5	4
Car (small)	10	5
Car (utility)	5	3
Taxi (small)	3	1
Taxi (utility)	2	2
Mini bus	15	8
Stand. bus	30	22
Rail/metro	0	40
Total	100	100

Table 36: Average vehicle occupancy

Vehicle type	Passengers/escorts		Employees/ visitors
	Domestic	International	
Two-wheeler	1.10	1.10	1.10
Auto	1.75	1.83	1.25
Car (small)	1.75	1.83	1.25
Car (utility)	2.38	2.71	2.20
Taxi (small)	1.55	1.82	1.50
Taxi (utility)	2.73	2.81	5.00
Mini bus	9.00	10.00	12.00
Stand. bus	15.00	15.00	20.00

8.15.3. Peak traffic

The estimated peak hour passenger and employee traffic in PCU's for each terminal is indicated in Table 26. The cargo traffic is estimated from cargo terminal on eastern side based on cargo traffic forecast and the assumptions of freight share, average tonnage carried by each vehicle and likely peak hour traffic. The estimated peak cargo traffic is presented in the following table.

Table 37: Expected peak passenger traffic on access roads, PCUs

Terminals	Final phase
Terminal-1	2,320
Terminal-2	2,666
Terminal-3	3,185
Terminal-4	3,132

Table 38: Expected peak cargo traffic on access roads, PCUs

Cargo	Final phase
Morning Peak	439
Evening Peak	351

8.15.4. On site facility requirement

The estimated traffic demand of passenger traffic (passenger, visitors, drivers, and employees) and cargo traffic has been utilized for analyzing future conditions at terminal forecourts and on main access road. The facility requirement estimation has been done based on traffic levels and the expected management of traffic on access roads, curbs, and parking areas.

8.15.5. Access roads

The required number of lanes for the main access road and the terminal access roads has been estimated for each phase, and are based on peak hour traffic forecast. It is estimated that the main access road on the western side will require 8+8 lanes, and although 2+2 lanes are assessed to be required based on PCU in the opening phase, 5+5 lanes need to be provided to accommodate additional traffic in future. Service road (2+2) is also proposed to serve all the offices and other units/utilities.

8.15.6. Parking demand

The likely parking demand for passengers, taxi staging, and employees has been estimated for all passenger terminals. The parking demand at forecourt and remote areas has been used to estimate the area required for parking of vehicles. An average car parking space of 30 sq. m per vehicle has been assumed. The generally accepted definition for short-term parking is anything less than three hours. Approximately 85 to 90 percent of all parking lot users are short-term parkers. The total peak hour passenger forecasts were used to estimate parking facility requirements. MLCPs have been planned to be provided at the four terminals on western side while a grade parking can cater to the demand on the eastern side. Remote parking has been mainly provided at grade away from forecourt areas. All

parking locations have been planned at 100 meters distance from the terminal facades in line with DGCA guidelines.

Table 39: Passenger vehicle parking requirement

	Opening	Short-Term	Medium-Term	Long-Term
Parking spaces	750	1,860	3,400	4250
Total Area (m²)	22,500	55,800	101,200	127,500

8.15.7. Forecourt

Terminal forecourts are conceptualized to efficiently integrate the planned multi-modal access to airport while providing required Level of Service to users. In line with terminal planning, arrival and departure curbs shall be vertically separated, and separate curbs will be provided for relevant traffic streams (e.g. private vehicles, taxis, VIP/valet), subject to detailed design and demand. Facilitating public transport is a key factor of the proposed Jewar Airport transportation strategy which includes buses and the proposed metro link. All buses are planned to operate at ground level to limit elevated roads and ramp burdens and capacity constraints. Buses pick up and drop off passengers at forecourt areas and long term waiting of buses will take place at a remote parking area away from the forecourt.

8.16. Support facilities

Support facilities planned for Jewar Airport form an important and integral part of overall airport development, and are essential for efficient and effective airport operations, airside operations, aircraft maintenance, airline operations, etc. Support facilities are varied in their types and functions, and are accordingly located on either airside or landside area of the airport. Several support facilities are jointly operated with airport stakeholders, and also need to be planned according to DGCA/ICAO guidelines along with other mandatory requirements. These facilities are planned within the airport site area in accordance to the airside, terminal and landside plan of Jewar Airport, and the functional needs of the respective support facilities. Within the airport development plan, it is also necessary to locate each of these facilities in a way in which maximizes functionality and increases flexibility for future expansion. This section of the report outlines the planned support facilities envisaged as part of the draft master plan.

There are three types of support facilities:

- Airline support facilities
- Airport support facilities
- Other facilities

As most of the support facilities are required from Phase I of Jewar Airport's operations, they have been planned for incremental expansion in various phases of airport expansion.

Airline Support facilities:

- Fuel farm;
- MRO facility;
- GSE maintenance facility;
- Flight catering;

Details about each of the above facilities and their extent/size requirements are detailed in following sections.

8.16.1. Fueling facilities

A fuel farm is proposed on site area of 4.00 ha to be located in the Western part of the airport site. Aircraft fuel is planned to be dispensed through an underground hydrant system that will be designed in accordance with relevant standards. The required fuel infrastructure for the initial phases is planned to be built prior to the opening of the airport and the facility could then be expanded in phases to meet demand. In Phase I the site area of Fuel Farm shall be 1.5 ha and it shall expand to 4.0 ha in Final Phase provided there is no change in technology. The anticipated fuel farm facility requirements for Phase I and the Ultimate are indicated in the following table.

The manner in which the fuel facilities are operated has significant impact on the scale of facilities to be provided over and above those driven purely by the forecast demand, in particular:

A minimum of 4 tanks are required at any phase irrespective of the level of demand to support a safe and resilient operation:

- one for receipt by tank trucks;
- one for receipt by pipeline;
- one for settlement after receipt; and
- one for delivery to aircraft.

An inventory of a minimum 7 days should be held at all times to provide adequate contingency for unforeseen interruptions in supply. The calculation of the required storage capacity has then been based on the following assumptions:

- Tanks with a height of 18 meters and diameter of 25 meters giving a useable capacity of approximately 7500 cubic meters13;
- 40% average uplift - to allow for sector length and aircraft refueling elsewhere;
- an average fuel uplift of 15 cubic meters per aircraft departure in the ultimate phase, reflecting the forecasted fleet mix and an average 40% fuel uplift;
- a seasonality peaking factor for peak periods of 15%;
- a peaking factor for busiest days at 10%;
- Jet A1 density of 840 kg/ cubic meter
- tank bund area is approximately twice the area of the tanks themselves; and
- support facilities, control buildings, car parking etc. are approximately 50% on the bund area. Applying this methodology and assumptions gives a nominal requirement of 2 tanks at Phase I and 13 tanks at the ultimate phase. However, for operational reasons set out in this section, it is necessary to have a minimum of 4 fuel tanks to maintain safe and efficient operations. Therefore, it is assumed that four, 25 meter diameter tanks of 18 meter height will be provided during phase I. Although this capacity may seem high, but it safeguards for the growth of the fuel facilities to support Jewar Airport.

Table 40: Fuel farm facility requirements

Fuel farm facility requirements	Phase I (12 MPPA)	Final phase (70 MPPA)
Total circulation and support building area (square meters)	5,000	16,250
Total area for tanks (square meters)	10,000	32,500
Number of tanks (square meters)	4 (2 nominal)	13
Capacity required (cubic meters)	11,700	93,300
Total plot area of fuel farm (square meters)	15,000	40,000

8.16.2. MRO facility

Total area of 40 hectares on the eastern and western side of the airport has been earmarked for Maintenance, Repair and Overhaul (MRO) facilities, and this may be developed in phases. Jewar Airport has a strategic location advantage of becoming an MRO hub. Currently, airlines operating in

India depend on foreign destinations for MRO (attributable to cost advantages and lack of MRO service facilities in India). Planning of an MRO facility at Jewar Airport will warrant significantly larger revenues for the government and will create local employment.

It is planned that the MRO facility will consist of apron, aircraft hangars, airside, landside circulation, and support/ancillary facilities. The area planned is sufficient to accommodate up to four Code E aircraft hangars and their corresponding aprons.

8.16.3. GSE maintenance

GSE Maintenance facilities have been planned on a total area of 4.0 hectares, spread across in parts having close proximity to apron areas. About 1.0Ha area has been allocated for developing the GSE in the Opening Phase.

8.16.4. Flight kitchen (in-flight catering)

The flight kitchen facilities, commonly referred to as catering facilities, have been planned with a final phase area of 2.0 hectares. As per plans, it is located in northern parts of the airport site .The proposed catering facilities at Jewar Airport may be developed in phases, and have been planned to include truck parking, kitchens, food preparation areas, refrigerated storage, non-refrigerated storage, break rooms, locker facilities with showers and restrooms, offices, landside delivery areas, and car parking. It is expected the facility will be developed by either a concessionaire which will service all or most of the airlines. Alternately it may be developed by the airlines themselves.

8.16.5. Air rescue and fire fighting

ARFF facilities will be developed on airside of Jewar Airport to provide Category 10 coverage in accordance with the relevant standards of ICAO. The ARFF facilities will be phased with the first facility constructed to support the single runway in Phase I. A second ARFF facility is planned to augment the system and meet the safety norms of DGCA/ICAO when the second runway is constructed.

The ARFF facility is planned to include a building, watch tower (non-satellite), fire tender parking, staff areas for welfare, and parking for ARFF, as well as storage of water, extinguishing agent, and firefighting equipment.

Considering the fact that the site is prone to low visibility three substation are also planned, one to serve the Cargo Complex and the other two close to the runway extremity and commercial areas.

8.16.6. Meteorological/ IMD facilities

Provision has been made for installation of all the MET equipment required for forecast and aircraft operations at sites as per operational requirements formulated by ICAO and promulgated by DGCA. A

meteorological station is planned to be collocated with the ATC facilities. But in case the IMD insists on a separate site, an area of 0.76 hectares in northern part of the airport with landside access from the 70 meters road has been provided for.

8.16.7. Authority facilities

Although the issue of providing free facilities to State Govt Aircraft has not yet been deliberated upon, but in line with such requests at other Greenfield airports an area for authority facilities is planned in the Northern part of the airport site adjacent to GA on land area of 1.00 ha. This shall include apron area for State's own aircraft and space of buildings/hangars.

8.16.8. Customs facility

A site for a Custom's facility is planned in the eastern part of the site near the cargo facility on site area of 0.4 hectares.

8.16.9. Animal Quarantine Services

A site for an Animal Quarantine Services facility is planned in the eastern part of the site near the cargo facility.

8.16.10. Airport maintenance building

Airport maintenance facilities are planned to include workshop(s), storage, vehicle and equipment parking areas. The airport maintenance facilities are planned to be located on landside in the north and south of the site on land area of 2.0 hectares. Airport maintenance facilities will be developed in phases to meet demand and requirements.

8.16.11. Airport offices and administration building

An administration building is proposed in the western landside area of Jewar Airport on site area of 2.0 hectares with access from central access road.

8.16.12. Airport Health Organization

A facility for the Airport Health Organization (AHO) is planned as part of western landside area of JIA on site area of 0.4 hectares.

8.17. Utilities

This section outlines proposed utilities as part of Initial Master Plan of Jewar Airport. The proposed utility systems for Jewar Airport shall be developed in phases, in accordance with demand. Overall airport wide utility demand based on passenger and cargo traffic has been benchmarked against similar international and Indian airports, and the detail assessment in this regard is in progress. These shall be finalised in next stage of JIA Master Planning. Preliminary demand assessment for JIA is indicated in this section. However, all proposed utilities and resource requirements shall be in accordance with EC granted for the project.

Systems such as the water treatment, water storage and sanitary treatment facilities will be developed as modular systems. Initial infrastructure development of these systems will provide capacity for the opening phase, with additional modules added in later phases as demand dictates. Underground trunk utilities including all storm sewers, sanitary sewers, water supply and distribution pipelines will be constructed to the as per final phase requirements. Emphasis will be placed on “green” solutions for the reuse of storm water runoff and sanitary effluents. Utilities infrastructure will be constructed and located such that they minimize the constraints on future airport development. Trunk infrastructure will also be located within protected corridors and road rights-of-way wherever possible. Alignments will be developed to minimize connector distances to trunk facilities and utility networks serving the individual area developments keeping in mind future expansion of these developments.

The proposed utilities at Jewar Airport include:

- Power
- Water supply
- Sewage treatment
- Solid waste treatment
- Storm water drainage

8.17.1. Power

Jewar Airport shall be connected to external power grid. Power shall be provided through a set of Primary Distribution Station (PDS) with power distribution phased to meet demand.

The expected power demand for Phase I is 20 MVA (connected load) and in final phase shall be 150 MVA. It is proposed to have two 400/220 KV feeds to PDSs located in landside areas of Jewar Airport.

In addition to mains power, solar and emergency power sources have been planned to be employed in phases to meet demand:

8.17.1.1. Emergency power

Security and diversity of power supply shall be provided as per ICAO and Municipality requirements together with emergency back-up generators to cater for a Demand Load of 60% of the Connected Load. This basis is considered important for reliability of airport operations. Emergency loads will include the following, and are considered as priority loads:

- Emergency egress lighting;
- Exit signage;
- Fire alarm system;
- Emergency evacuation system (public address);
- Security system for egress doors;
- Fire pumps (sprinklers);
- Stair pressurization system; and
- BHS fire shutter operation (in the case of terminals)

8.17.1.2. Solar power

A solar farm has been planned in the northern and southern part of the airport site spread over area of 9.5 hectares, and shall be supplemented by solar panels on roofs of some of the airport buildings wherever possible, subject to assessment of glare hazard to aircraft operations. The power generated from solar sources shall be distributed for select purposes to ensure that security of supply requirements on critical systems is not compromised.

8.17.2. Energy efficient lighting

Currently it has been planned to deploy Light Emitting Diode (LED) lighting for area lighting, signage, terminal buildings and airfield lighting. Additionally, occupancy sensors are planned to be deployed wherever appropriate to conserve energy.

8.17.3. Water supply

The estimated total water demand for Phase I is 9 MLD, and for final Phase is 39 MLD. Sustainability measures may be employed for the airport infrastructure development to optimize water consumption. Measure are planned to include rainwater harvesting, water recycling, low usage fittings, and irrigation

strategies. Rainwater harvesting ponds have been planned as part of Initial master plan for Jewar Airport, and have been strategized for integration with overall drainage plan of the airport.

Potable water requirements for non-firefighting purposes

The total fresh water/potable water demand in Phase I is 1.6 MLD.

Requirements for Water for Fire Fighting Purposes

Fire water distribution mains will be provided in accordance with the NBC. All buildings shall be required to provide for an adept code compliant Fire Fighting System which will cover overall aspects of fire prevention and firefighting. The built-in systems will include fire detection, fire alarm along with protection and fire fighting in the event of a fire. The design will cover accessibility for firefighting systems, space for machineries, provision for emergency lighting and other equipment.

Water Storage Requirements

It has been proposed to provide raw water storage at site to ensure an unimpeded supply to the water treatment plant. Treated water storage of at least 1.5 days of supply shall be maintained with some of this storage happening within the terminal buildings, support facilities, and ARFF.

Chilled Water

HVAC and chilled water systems will be provided and designed in accordance with ASHRAE/ISHRAE standards. Chiller buildings are planned to minimize energy loss and may also include variable frequencies drive or heat recovery wheels in the equipment for optimum energy saving.

8.17.4. Sewage

The overall estimated sewerage generation is 15 MLD, and Phase I demand is 1.3 MLD. In phase I Sewage Treatment Plant (STP) of 1.5 MLD has been proposed. In final phase two separate STPs have been planned for Jewar Airport. One STP has been planned on the western part to serve the entire passenger and support facilities. The second STP has been planned on eastern part to serve the cargo, MRO and other facilities of Jewar Airport. Gravity sewage systems will deliver into a network of pump stations which will deliver sewage to either STP.

A dedicated distribution network will be planned to supply recycled water as makeup water to chillers, flushing water to the terminal and other buildings and various landscaping areas for irrigation. 80% water recovery from the STP is expected to be fed back into the water supply for non-potable water demand, to reduce the demand of raw fresh water.

8.17.5. Solid waste

Solid waste collection and processing facilities are required in order to process and dispose different types of waste generated at the airport. Waste generated shall be segregated into dry and wet waste and shall be treated and disposed as per relevant regulations. Solid waste collection and recycling facilities have been planned in the eastern and northern part of the airport site. The estimated total solid waste generation for Phase I is 6 tons/day, and in final phase it is 40 tons/day.

8.17.6. Aircraft waste

Aircraft waste largely consists of catering wastes, papers, and liquid waste. The solid waste will be collected and disposed of in accordance with the applicable regulations. The liquid waste, before mixing with the main sewerage system, shall be collected in an equalization tank and adequately sanitized. The equalization tank will be provided as an extended part of the waste water treatment facility located in the northern part of the airport site.

8.18. Other facilities

- Police aid post;
- Police station;
- Security checkpoints;

8.18.1. Police aid post

As part of State's obligation, as noticed in other Project Documents, Authority shall assist the concessionaire in procuring assistance from police to set the Police aid post at the airport. It is understood that after the completion of construction of phase I infrastructure for the airport, the Authority shall provide the required assistance as required by the concessionaire for setting up the Police aid posts. Accordingly provision has been made for providing a police aid post at each of the car- park areas.

8.18.2. Police station

A police station is planned on the landside area of Terminal 1 of Jewar Airport, on a land area of 0.2 Ha just adjunct to the terminal.

8.18.3. Security check points

Security check points have been planned for screening of vehicles entering Jewar Airport, on western main central access road leading to terminals as well as on the eastern access road leading towards cargo facilities. A security check point is also planned in the northern part of the airport site (the 70

meter wide northern road). This will enable screening of vehicles accessing facilities in the area such as GA terminal, State Govt. facility etc.

8.19. Communication systems

The Communication system will be designed to offer ease of operation, maintenance, and flexibility for incorporation of future technologies. The Jewar Airport will be linked to the BSNL telecom and data network through fiber optic link dedicated for airport operations. The telecommunications network shall be distributed through two fiber optic backbones within the airport. This shall be split into a general airport network and a secure use dual distribution network. The fiber will be distributed throughout the Airport going into the various PABX for copper based CAT VI communications distribution to all voice and data users within the various facilities. Communications backbone shall carry data and voice services as necessary over a mix of fiber and shorter run copper cables with hi speed configuration.

All shall be laid with two levels of redundancy in number of runs as route or runs between various points of the network. Upon this telecommunications network shall be a host of very diverse, productive and efficient systems for safety, communication, and various daily operations.

A secure use system will provide communication between the Navigation Aids and form a ring connecting the:

- ATC Tower;
- Met equipment;
- ILS equipment on each runway;
- ASR and SMR; and
- DVOR's.

Based on above detailed analysis for each of the facility, service requirements, and performance and safety standards and in conformity with the ICAO SARP, DGCA's CAR, BCAS guidelines, and other stakeholders' needs, a detailed Draft Master Plan concept has been developed and placed in Annexure.

8.20. Airport development phasing

Jewar Airport's passenger terminal(s) shall be developed in phases in accordance with traffic demand. It shall be designed to emerge as a unified, integrated architectural form- a synergetic functioning of smaller terminals built in different phases.

The development process shall endeavor towards enhanced integration of emerging, innovative IT processes for more efficient, secure, and fast airport operations. Airport development being a dynamic process, is also dependent on macro and micro level economic indicators, regulatory regime, technological factors etc. The aviation demand dynamics of the region is also a key driver. The proposed development of Jewar Airport shall be in phases, linked to projected traffic growth.

In view of the dynamic nature of airport development process, required flexibility in airport planning and implementation is essential to accommodate emerging airport needs and requirements of future.

Airport development being a comprehensive, complex long-term process with involvement of several stakeholders and users, a holistic, integrated airport development vision shall provide direction and cohesion to the overall effort. It is even more important as the project needs be implemented in a highly competitive environment as a second international airport to serve the NCR.

Proposed Jewar Airport master plan is planned to achieve initial airport passenger handling capacity of 12 million passengers per annum and 0.7 million tons of cargo per annum in Phase I. The final phase passenger handling capacity of Jewar Airport is estimated at 70 million passengers per annum and cargo handling capacity of 3.0 million tons per annum. As the development phases of Jewar Airport are linked to traffic triggers, there would be intermediate phases of development between initial phase and final phase. The facilities proposed in the first phase are based on the traffic forecast, and there are chances that demand on some subsystem(s) may be greater than estimated or the type and frequency of aircraft utilizing the facilities may differ. Hence, in planning for facilities, adequate flexibility has been built to accommodate for such uncertainties. For example in case of apron size 15-20% of bays have been designed to accept even the higher category of aircraft to cater for seasonal, charter or special events demand. The flexibility introduced in the subsystems, is to ensure that the plan is adaptable even if any of the elements exceeds the envisioned demand level.

8.21. Implementation plan

The implementation plan/ creation or upgradation of facilities for various phases is given in this section.

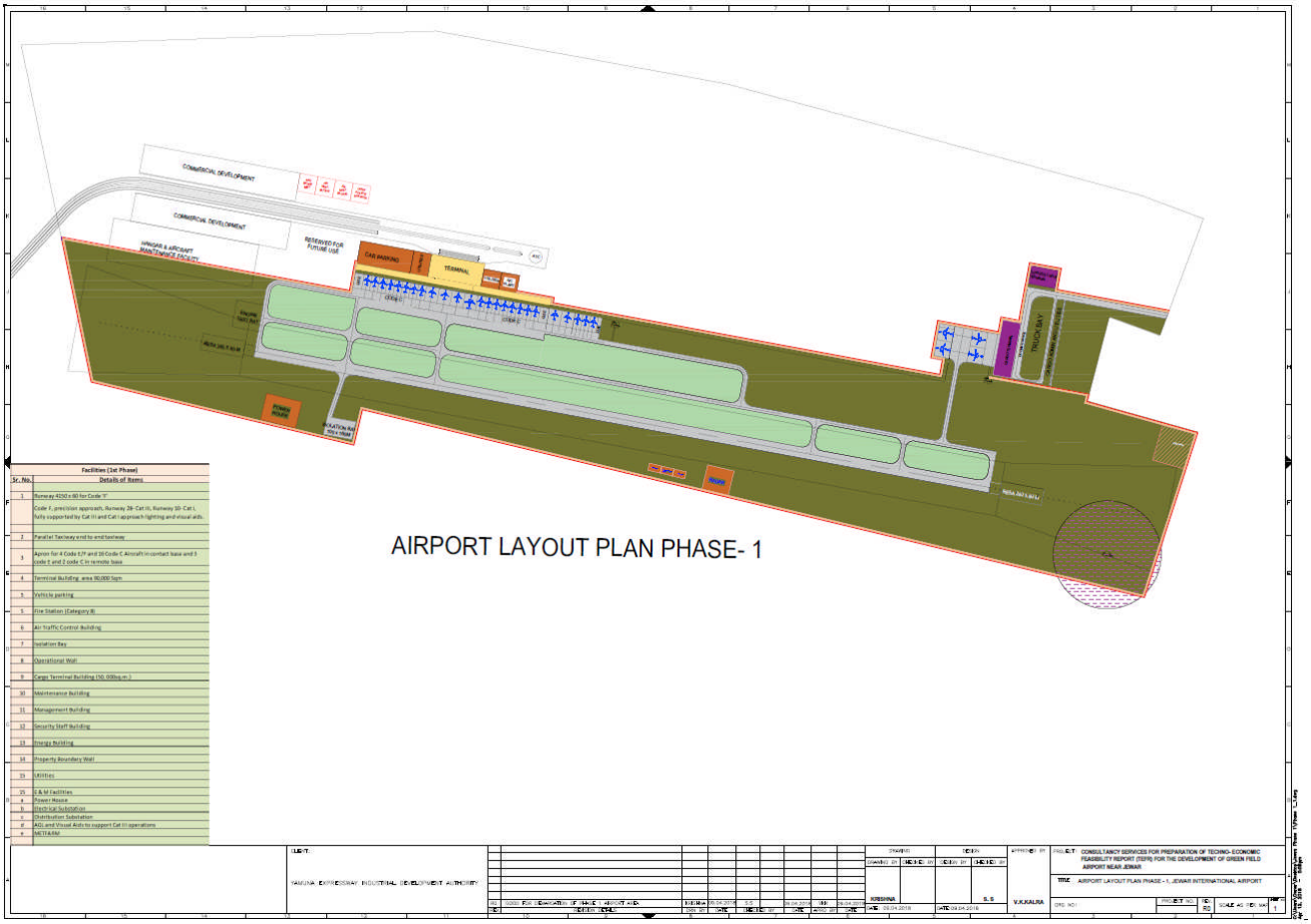
In the opening phase of the airport, it is proposed to construct the facilities mentioned in the matrix placed below.

Facilities (1st Phase)	
Sl. No.	**Details of items**
1	Runway 4150 x 60 for Code 'F'
	Code F, precision approach, Runway 10/28- Cat III, , fully supported by Cat III ILS and approach lighting and visual aids.

2	Parallel End to End Taxiway
	Taxiway with two rapid exits conforming to Code F and Cat III requirements.
3	Apron for 4Code E/F and 21 Code C Aircraft with built in capacity to accommodate up to 5 Code E aircraft
4	Terminal Building for peak 2750 Pax. Capacity (Total Floor Area of 90,000 sq.m., Swing Gate operation)
5	Fire Station (Category 9)
6	Air Traffic Control Building
7	Isolation Bay
8	Operational Wall
9	Cargo Terminal Building (50,000 sq.m.)
10	Maintenance Building
11	Management Building
12	Security Staff Building
13	Energy Building
14	Property Boundary Wall
15	E & M Facilities
a	Power House
b	Electrical Substation
c	Distribution Substation
d	AGL and Visual Aids to support Cat III operations
e	METFARM

The Airport Layout Plan on the airport opening day is depicted in the plan placed below. A large scale drawing showing the facilities provided is placed at Appendix M. -..

Figure 75: Phase I plan



Set of above facilities are capable of supporting Code E aircraft operation and 2750 passengers in an hour with service level C. The Cargo facility at the airport is capable of handling on an average of around 2000 ton of cargo per day.

Further development of the airport should be undertaken when 80% of the above capacity on an average is utilized over a rolling period of past six months. The expansion planned should take the average rate of growth into account and must be planned such that on the day of its commissioning, the existing facilities are operating at 50% of design capacity (unless the future growth rate justifies a lower utilization rate).

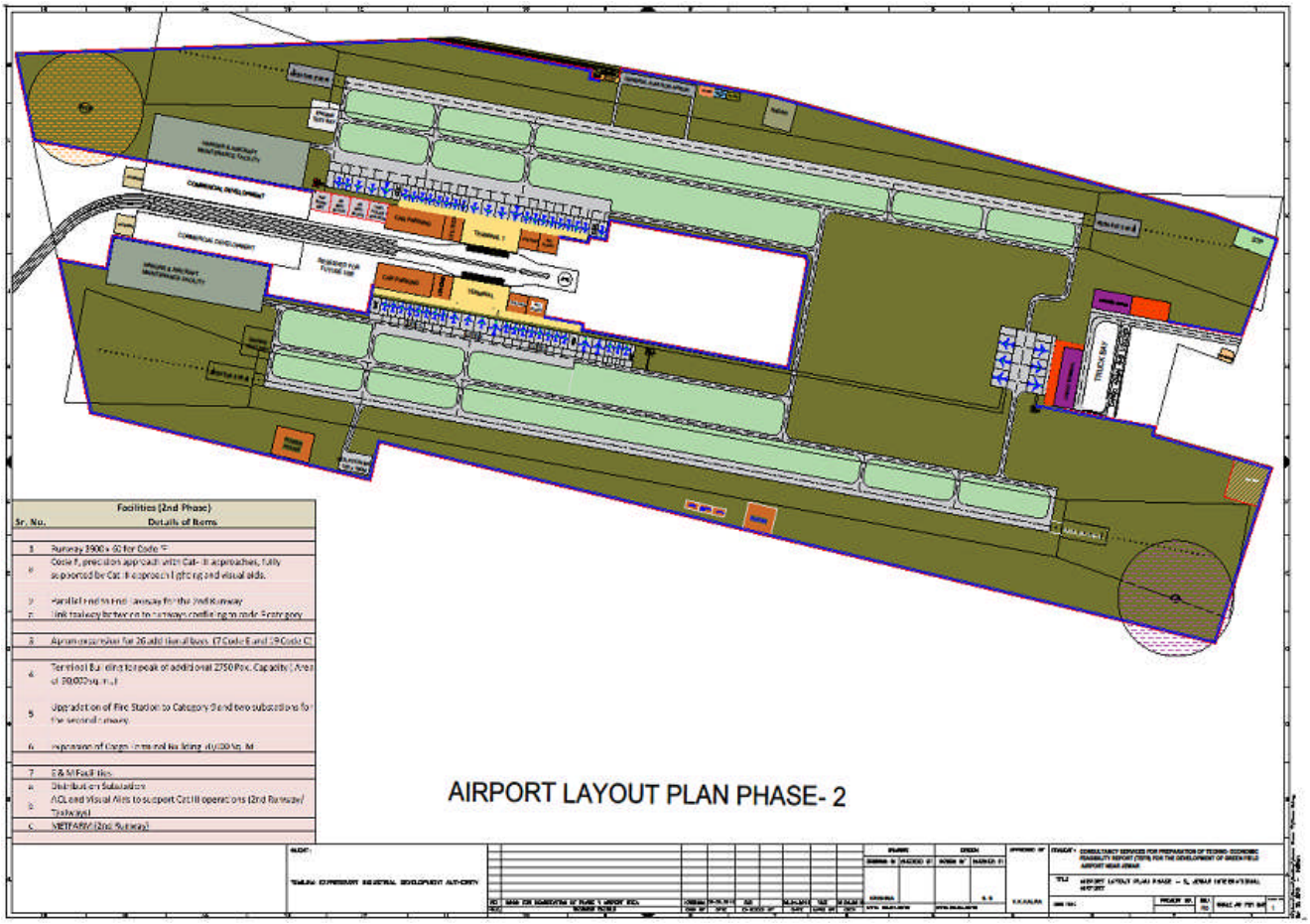
Considering the projected forecast, it is planned to initiate the construction process for the short term, The facilities proposed to be provided are listed in the matrix for the second phase.

Facilities (2nd Phase)	
Sl. No.	**Details of Items**
1	Runway 3900 x 60 for Code 'F'

a	Code F, precision approach with Cat- III approaches, fully supported by Cat III approach lighting and visual aids for Rwy28R and Cat I for Rwy10 L
2	Parallel End to End Taxiway for the 2nd Runway
a	Taxiway System conforming to Code F and Cat III requirements.
3	Apron expansion for 27 additional bays (2Code E and 25 Code C) with flexibility to accommodate 5Code E aircraft.
4	Terminal Building for peak of additional 2750 Pax. Capacity (Total Floor Area of 90,000 square meters, Swing Gate Operation)
5	Up-gradation of Fire Station to Category 10 and two substations for the second runway.
6	Expansion of Cargo Terminal Building (20,000 sq.m.)
7	E & M Facilities
a	Distribution Substation
b	AGL and Visual Aids to support Cat III operations (2nd Runway/ Taxiways)
c	METFARM (2nd Runway)
8	Augmentation of all the utilities to match the enhanced infrastructure.

On completion of the development envisaged for the short term, the airport layout plan shall be as depicted in the figure below. A large scale drawing showing the facilities provided is placed at Appendix N. -.

Figure 76: Phase II plan

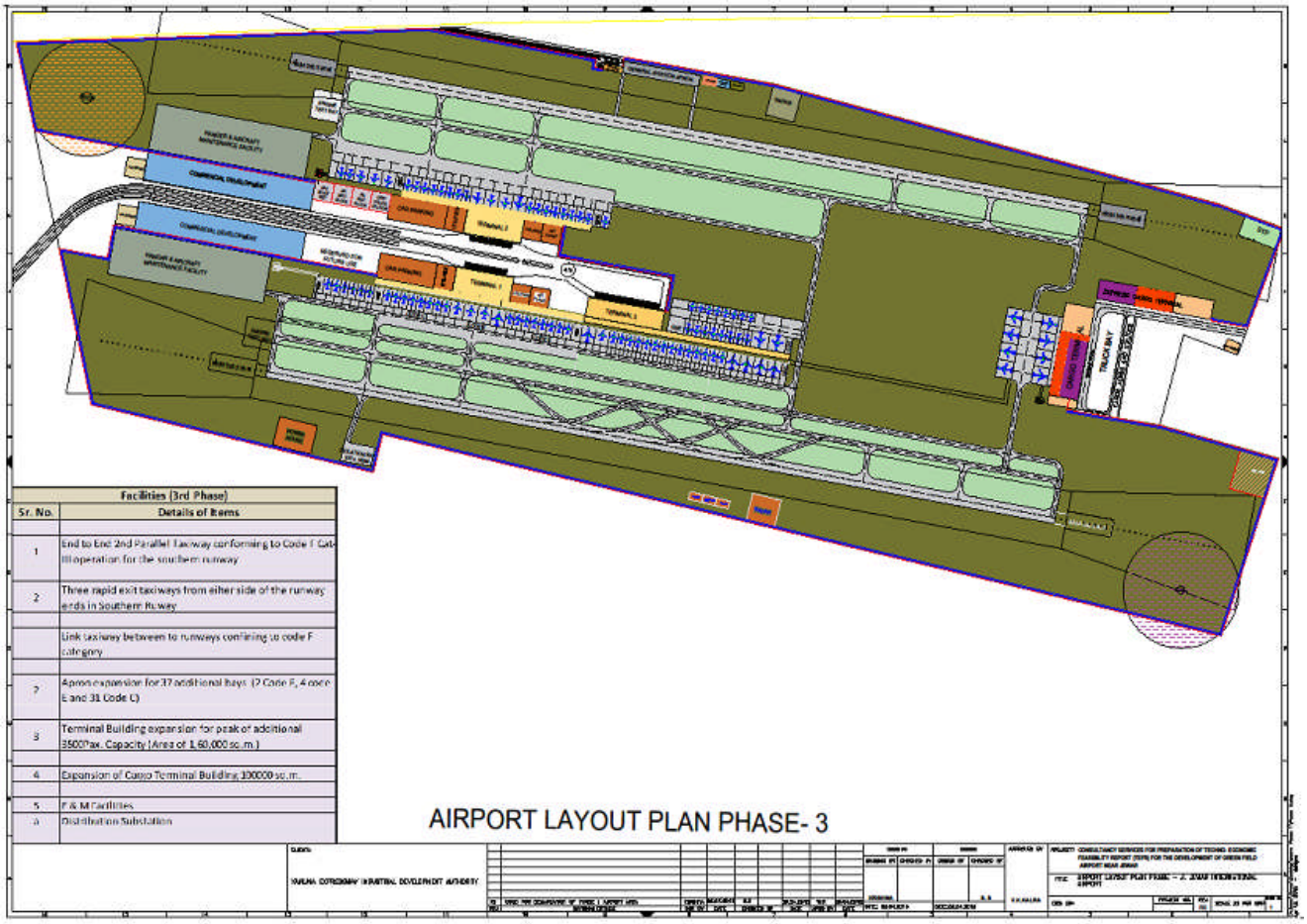


Following the norms as indicated above for the short term development, medium term development may be undertaken when the expanded capacity get consumed by 80%. In case any individual subsystem shows signs of overloading attempt must be made to augment capacity of that subsystem and not the system as a whole. However, after the medium term development the airport layout would appear as depicted in the plan placed below. A large scale plan with list of facilities developed in the third phase is placed at Appendix O. -.

Facilities (3rd Phase)	
Sl. No.	**Details of Items**
1	End to End 2nd Parallel Taxiways conforming to Code F Cat- III operation
2	Apron expansion for 25 additional bays (2 Code F, 4 Code E and 27 Code C)
3	Terminal Building expansion for peak of additional 3500 Pax. Capacity (Total Floor Area of 1,60,000 square meters)
4	Expansion of Cargo Terminal Building (30,000 sq.m.)
5.	Three Rapid exit taxi tracks for each of the runway 10R/28L

5	E & M Facilities
a	Distribution Substation

Figure 77: Phase III plan

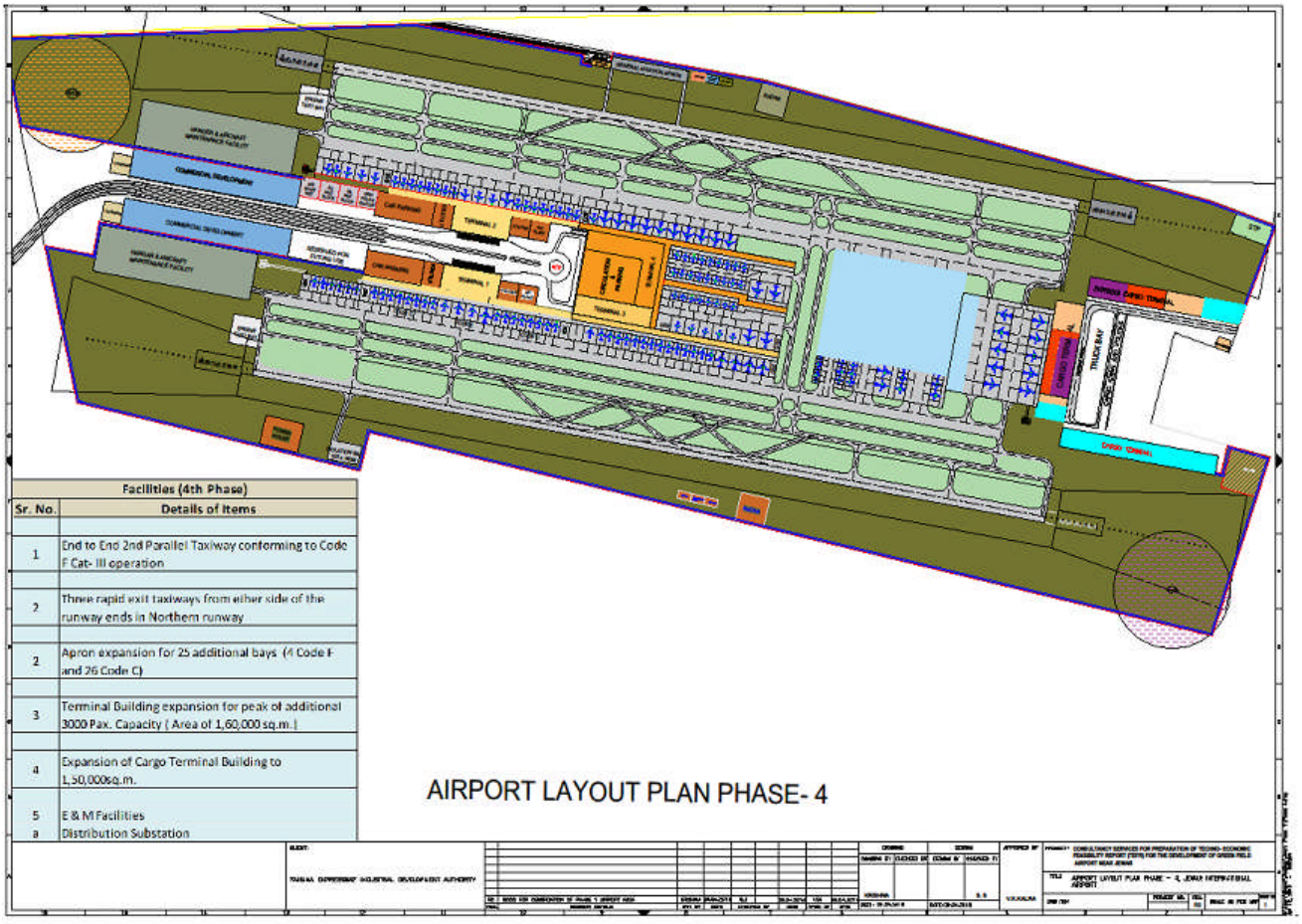


Close to the capacity saturation, and depending upon the growth rate, further expansion must be undertaken. The design year for this phase of expansion will be crucial. However, considering the forecast in hand, this shall be the ultimate phase of development (1st Stage). List of facilities to be added and upgraded is provided in the matrix placed below. Further expansion of the capacity/ throughput would be marginal as the runway system is expected to reach its safe handling limit. Any further increase in aircraft movements may be possible due technological advancement, which can't be visualized at this stage. For further development of the airport, a third runway would be necessary. The third runway can be placed at approximately 1600mt from the existing southern runway further south and the area in-between the central runway and the new southern runway utilized for passenger handling, parking and other support facilities.

Facilities (4th Phase)	
Sl. No.	**Details of Items**
1	End to End 2nd Parallel Taxiway conforming to Code F Cat- III operation
2	Apron expansion for 25 additional bays (2Code F, 10 Code E and 24 Code C)
3	Terminal Building expansion for peak of additional 3000 Pax. Capacity (Total Floor Area of 1,60,000 square meters)
4	Expansion of Cargo Terminal Building (50,000 sq.m.)
5	Three Rapid exit taxi tracks for each of the runway 10L/28R
5	E & M Facilities
a	Distribution Substation

After this phase of development the airport layout would appear as follows. A large scale plan is provided at Appendix P. -..

Figure 78: Phase IV plan



Proposed Master plan is placed at Appendix K. - A conceptual development plan showing the third runway in the Stage 2 of development is placed at Appendix L. -

From the layout plan in Appendix it is seen that some areas may still be available in airside for augmentation of facilities. But since the runway system has reached its capacity, the balance area at best can be utilized for development of additional Parking space for aircraft (as a night parking, long term parking, or additional cargo parking area) or could be utilized for MRO/Training facility.

9. Capital expenditure (CAPEX) profiling

9.1. CAPEX profiling

Preliminary project cost

Item No	Item	PROJECT COST		(in Million INR)	
		PHASE -I	PHASE-II	PHASE-III	PHASE-IV
1000	CIVIL WORKS (Mandatory)				
1100	Property Boundary Wall	152			
1200	Operational Security Wall	57	57		
1300	Perimeter Security Road	400			
1400	Approach Roads	700	700	2500	2500
1500	Air Side Drainage	100	100	50	50
1600	Air Side Water Harvesting	50	50		
1700	City Side Drains	100	100		
2000	E&M WORKS				
2100	Electrical Receiving Station	750	250	750	250
2200	Approach Roads Lighting	100	100	200	200
2300	Perimeter Lighting	60	20		
2400	Perimeter Security				
3000	AIR SIDE CIVIL WORKS				

Item No	Item	PROJECT COST (in Million INR)			
		PHASE -I	PHASE-II	PHASE-III	PHASE-IV
3100	Runway, Taxiway, Aprons, Isolation Bay	6000	6000	1500	1500
3200	Air Side Drainage				
3300	Air Side Grading incl RESA	120	125		
3400	Service Roads utilities and facilities	100	100		
3500					
4000	**BUILDINGS**				
4100	Passenger Terminal Building	10800	10800	19200	19200
4100 A	Interconnectivity (APM terminals)		2000	3000	3000
4200	Cargo Terminal Building	2100	2100	2100	4900
4300	Maintenance Building	120	70	70	70
4400	Control Tower + ATM + MET	1000			
4500	Management Building	450	100		
4600	Security Staff Building (Office +Staff Housing)	250	80	80	80
4700	Energy Buildings	270	160	200	200
4800	Fire Fighting Buildings	168	72	36	36
4900	Other Buildings (LLZ GP DVOR, ASR/MSSR/ Car Parking etc)	900	900	800	800
5000	**E&M WORKS**				
5100	AGL works	1500	1500	200	200
5200	Power SubStations	200	200	200	200
5300	IE of all Buildings and HVAC	50	50	10	10

Item No	Item	PROJECT COST (in Million INR)			
		PHASE -I	PHASE-II	PHASE-III	PHASE-IV
5400	Remote Monitoring and Control of All the Facilities (BMS)	350	350	350	350
6000	EQUIPMENT				
6100	Fire and Safety Services	750	700	200	200
6200	Operational Vehicles	50	20	20	20
6300	Security Equipment	500	500	600	600
6400	Cargo Equipment	350	200	200	350
6500	Flight Information System	100	100	150	150
6600	AOCC	500	120	120	120
6700	Misc. (Birds Control System, Visual Aids, Emergency and Medical etc.)	15	15		
6800	Terminal and Office /communication/Security Equipment.	1000	1000	1000	1000
6900	Passenger Equipment	500	500	700	700
7000	UTILITIES				
7100	Communication Facility	100	100	150	150
7200	Water Supply Facilities	200	200	200	200
7300	Waste Disposal Facility	200	300	300	300
7400	Fuel Facility #				

Item No	Item	PROJECT COST		(in Million INR)	
		PHASE -I	PHASE-II	PHASE-III	PHASE-IV
8000	**LANDSCAPPING**	**1200**	**1200**	**750**	**750**
9000	**Temporary Works**	70	30	30	30
		32382	30969	35666	38116
	Contingency	3541	2878	3368	3836
	Consultant Fee (DSM)	1617	1523	1757	1888
	Total capital cost	**37540**	**35370**	**40790**	**43840**

10. Operating expenditure

Operating expenditure include staff costs, utilities, repairs & maintenance, and others. The level of service provided at the airport is directly linked to the operational expenditure incurred at the airport. The following section provides details on the benchmark used to estimate operating expenditure expected to be incurred at the proposed airport at Jewar.

10.1. Staff cost

An assessment of employee strength vis-à-vis passenger reveals that airports employ one employee per 11,000-39,000 passengers handled annually. It may be observed that for airports run by AAI, one person is employed for every 16,000 passengers handled annually. For airports under PPP mode, one employee is engaged for 28,000 passengers handled annually.

Figure 79: Key parameters at Indian airport

Airport	Employees excluding CNS	Passengers (annual)	Passengers per employee
Ahmedabad	178	6,480,111	36,405
Bhubaneshwar	108	1,894,732	17,544
Calicut	199	2,305,547	11,586
Coimbatore	129	1,691,553	13,113
Jaipur	174	2,887,189	16,593
Lucknow	214	3,241,892	15,149
Mangalore	108	1,674,251	15,502
Tiruchirapalli	102	1,297,212	12,718
Vishakapatnam	50	1,804,634	36,093
Mumbai	1063	41,670,351	39,201
Bangalore	836	18,971,149	22,693
Delhi	1461	48,424,165	33,145
Cochin	400	7,749,901	19,375
Chandigarh	40	1,534,058	38,351

Proposed airport at Jewar is expected to maintain service levels observed at other PPP run airports in India. Given the service level requirements, the number of staff employed at the Jewar airport shall be directly linked to the traffic at the airport (see table below). Hence, given the traffic profile at Jewar, around 20,000 passengers are expected to handled by 1 employee. Considering average employee cost of 1.3 million INR, the estimated employee strength translates into total staff cost of about 440 million INR in FY23 which ramps upto INR 6280 million INR in FY38.

Figure 80: Staff employed by range of traffic

Traffic range (mn)	Employee
3mn-7mn	250
7mn-12mn	500
12mn-20mn	800
20mn-30mn	1,250
30mn-40mn	1,750
40mn-50mn	2,250
50mn-60mn	2,875

10.2. Utilities

10.2.1. Electricity

Electricity consumption is driven by the total terminal area of the airport. Benchmarking with other airports reveals that about 1 ton of HVAC load is required to over about 340 square feet of area. On the other hand, cost arising out of lighting requirement is estimated to be 10 watt per square meter. Considering the efficiency of HVAC equipment and lighting equipment at about 80%-90% and the cost of electricity at 6.90 INR per kWh, the total electricity cost at Jewar airport is estimated to be 160 million INR in FY23 which ramps up to 2550 million INR in FY35.

10.2.2. Water

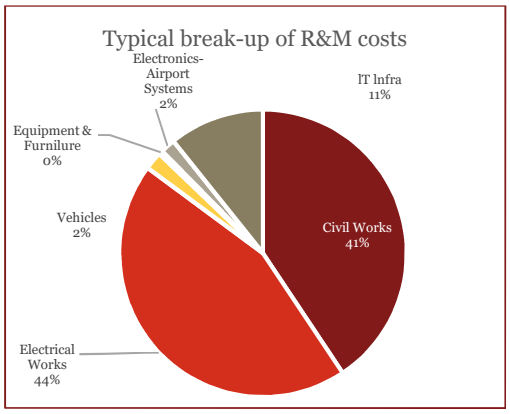
Water cost has been estimated based on per day water requirement and cost of water supply in Uttar Pradesh. Basis benchmark, it is estimated that the water requirement per passenger per day is around 15 liters. The cost is relatively higher for the staff at 70 liters/day. Given the passenger and staff profile at the proposed airport, water consumption cost translates to 10 million INR in FY23 to about. 40 million INR in FY28.

10.3. Repair, operations, and maintenance

10.3.1. Repair and maintenance

Repair and maintenance costs comprise of routine maintenance across several cost centers including R&M of civil works, electrical works, vehicles, equipment & furniture, electronics-airport systems and IT infrastructure. A typical breakup of the R&M costs is shown in the following figure. R&M in civil works and electrical works together account for more than 80% of the total costs.

Figure 81: Breakup of R&M cost



Data of 16 AAI airports and 4 private airports have been analyzed to estimate the benchmark R&M cost. The table below shows the benchmarks considered for each of the R&M cost element. It should be noted that the civil works and electrical works costs are directly proportional to the terminal area and hence the benchmarks are based on cost per meter square. Vehicle costs, on the other hand, is linked to the number of employees and the equipment costs is related to the number of passengers using the airport.

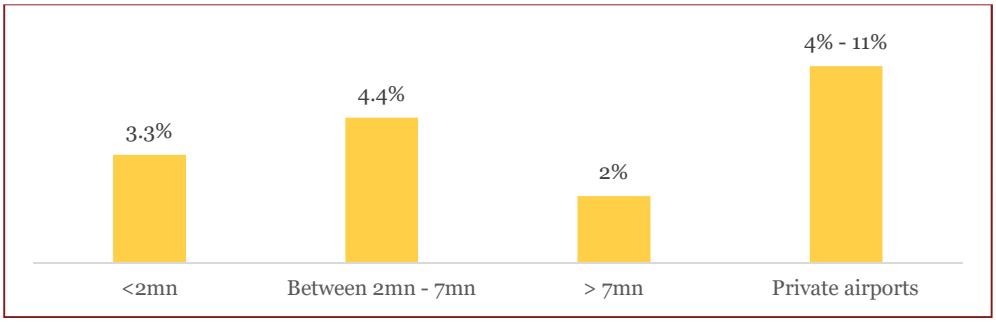
Table 41: R& M cost benchmark

Category	Cost benchmark (INR)
R&M Civil Work	1023 per sq m
R&M Electrical Work	1,516 per sq m
R&M Furniture, IT, and Equipment	13 per sq m
Other O&M Cost	1800 per sq m
R& M Vehicle Cost	10, 784 per employee

10.3.2. Consumables and spare

Consumables and spares are a function of the R&M expense. In the following figure, the consumables and spare cost as a percentage of the total R&M cost have been shown for various airport categories. For estimation of consumable cost, 5% of the R&M cost has been considered to be consumable and spare cost.

Figure 82: Consumables and spares as a percentage of R&M costs



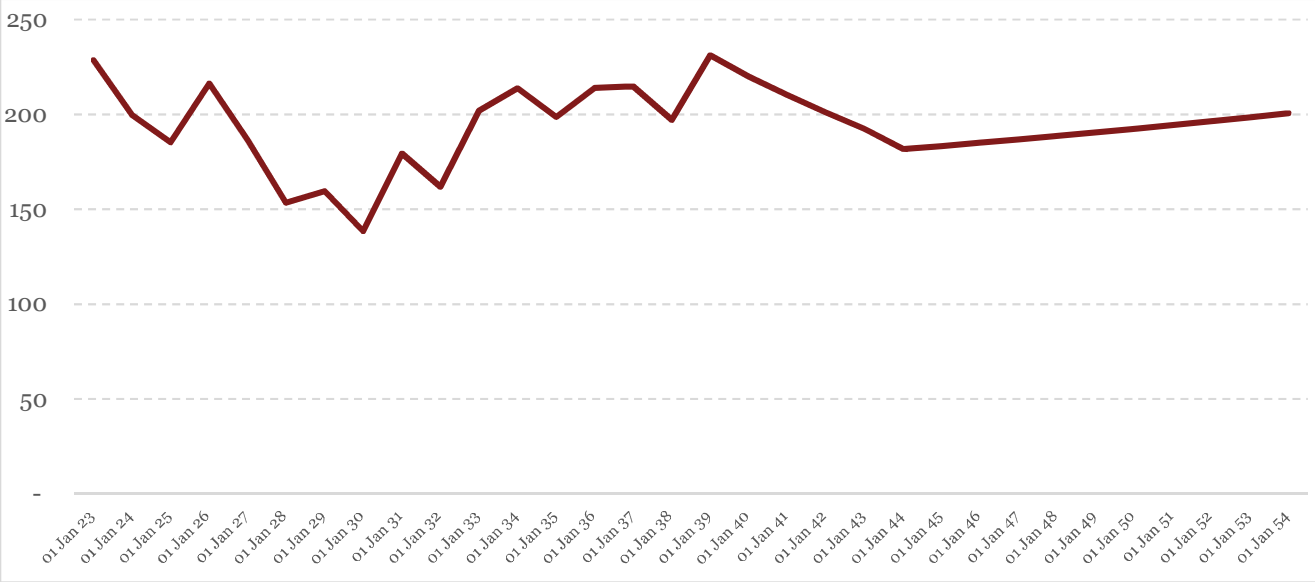
10.4. General administration and others

- **General administration cost:** The general administration cost has been estimated as a percentage of other costs. At airports, the administration cost is around 10-11 percent of other operating costs. Based on this benchmark, general administration cost has been estimated for Jewar airport.
- **Insurance cost:** Insurance cost in relation to cost of assets has been studied for domestic & international airports. At Zurich and Heathrow airports, the insurance cost as a percentage of gross block varies between 0.12 percent and 0.15 percent. At domestic airports such as DIAL and BIAL, the insurance cost as a percentage of net block is 0.14 percent. Based on these benchmarks, total insurance cost has been estimated for Jewar airport.
- **Marketing cost:** Airport operators often spend on marketing in order to attract airlines/passengers to the airport. Basis on the benchmark at other PPP airports, Jewar airport is estimated to incur around 6 INR per passenger.

10.5. Total operating expenditure

Based on the analysis presented, the total operating cost per passenger has been estimated (see following figure). In 2023, the operating expenditure per passenger at Jewar has been estimated at 229 INR per passenger. The operating cost per passenger increases during certain years due to commissioning of new terminal area. However, the total cost stabilizes to ~190 INR per passenger in the later part of the concession.

Figure 83: Operating cost per passenger (real terms)



11. Financial Assessment

The traffic and other commercial aspects of the airport feeds into the technical design and conceptual layout of the airport project. The expectation of international airport development at Jewar is not only to cater to the burgeoning traffic of the NCR and adjoining hinterland but also to act as a gateway airport to India's capital city as well as one of the most renowned tourist destination – Agra.

Likewise, the airport development is expected to rope in private sector participation for developing and transforming the project into a world class airport. Given the expected role of the private sector player, it is therefore important to not only assess the financial viability of the project but also to answer relevant questions pertaining to the quantum of the capital investment required and the desired return on investments, project's ability to service debt, robustness of the project assumptions under various scenarios etc. The objective of this chapter is accordingly set to analyze the financial viability of the project under realistic assumptions and assess the robustness and sensitivity of the financial results.

11.1. Key assumptions of the financial assessment

Before analyzing the outcomes of the financial model, following are the key assumptions under each head in the base case. For detailed set of assumptions, kindly refer to the relevant Appendix I. -.

11.1.1. Key dates

The financial assessment assumes the following key dates:

- Financial Closure – 31 March 2019
- Construction start at the airport – 1 April 2019
- First phase of land acquired by the government by March 2019
- Commercial operations date – 1 April 2023

11.1.2. Traffic

The traffic is in the base case assumes partial spillover from the Delhi and IGI's core hinterland. This spill will depend on the high speed connectivity and the location from where this connectivity gets developed. For the purpose of this TEFR, a high speed rapid metro connectivity from Sarai Kale Khan to Jewar, which connects Delhi passengers to Jewar airport within 45 mins has been assumed. This is based on the primary interactions with relevant stakeholders in the government including metro and transport authorities of NCR, and UP Govt. Please refer to the traffic section for more details.

Table 42 - Traffic at Jewar airport under base case

Year	2022 to 2023	2023 to 2024	2024 to 2025	2025 to 2026	2029 to 2030	2034 to 2035	2039 to 2040	2044 to 2045	2049 to 2050
Domestic passenger	4.67	5.48	5.99	7.07	15.21	29.22	47.56	65.13	86.35
International passenger	0.20	0.22	0.25	0.29	1.49	3.89	7.64	10.48	13.37
Total Passenger	**4.87**	**5.70**	**6.24**	**7.35**	**16.70**	**33.11**	**55.19**	**75.61**	**99.72**

11.1.3. Macroeconomic Assumptions

1. Overall inflation is assumed to be in line with the current trends of Consumer Price Index as published Government of India. For this study CPI of 4% has been assumed
2. The inflation pertaining to capital cost estimates have been assumed to follow the trend of last 10 year's Construction Cost Index (from Oct 2007 to Oct 2017) of 4%
3. Personnel cost have been assumed to increase in two ways –
    a. Year on Year increment in line with the CPI index
    b. A 15% jump over and above inflationary growth in salaries owing to salary growth, increments and promotions
4. The inflation pertaining to O&M costs including electricity, water costs, R&M costs have been aligned with the historical growth rates observed at various airports in India (including private sector airports as per AERA filings, annual reports etc.)
5. The short term growth of India's GDP is aligned with the forecast undertaken by International Monetary Fund (IMF) till 2022. Beyond 2022, the long term forecasts of OECD has been considered

11.1.4. Capital investment phasing

1. The phase wise capacity as per the conceptual masterplan has been assumed to be
    a. Phase 1 – 12 MPPA
    b. Phase 2 – 30 MPPA
    c. Phase 3 – 50 MPPA
    d. Phase 4 – 70 MPPA
2. The capital investment for future phases has been assumed to start once the traffic reaches 80% of the previous phase capacity, as highlighted in the table below:

Table 43 – Phase wise construction trigger assumptions

Phase capacity	Trigger for construction	Traffic trigger point	Previous phase
Phase 2 – 30 MPPA	Construction phasing trigger % - phase 2	80.00%	Of Phase 1 capacity
Phase 3 – 50 MPPA	Construction phasing trigger % - phase 3	80.00%	Of phase 2 capacity
Phase 4 – 70 MPPA	Construction phasing trigger % - phase 4	80.00%	Of phase 3 capacity

3. Given the constraints of two runway for the current land parcel consideration of approximately 1334 hectares, the phase 4 capacity is assumed to be restricted to 70 MPPA. The traffic at the airport is assumed to be capped at 110% of the maximum capacity over the concession period. Thus, although the traffic potential for Jewar airport has been estimated to be around 100 MPPA (*refer table in the assumptions on traffic*), the capacity constraints restricts the traffic to 77 MPPA in the later years (beyond 2042-43). The financial assessment under this TEFR therefore restricts the traffic beyond 2042-43 to 77 MPPA.

11.1.5. Terms of the Debt

Following are the key assumptions under this head:

1. Gearing ratio – The debt-equity ratio has been assumed to 70:30.
2. The interest rate for the term loan is assumed to be 10.5% p.a.
3. The door to door tenure of the loan including one year of moratorium for principal repayment has been taken as 14 years (3 years for construction, 1 year moratorium and 10 years for repayment)
4. One quarter of debt service reserve has been assumed to be maintained in form of debt service reserve account (DSRA)
5. The DSRA amount has been assumed to be maintained through bank guarantee and not through withholding cash
6. The cost of bank guarantee has been assumed to be 0.5% of the amount per annum
7. The interest for subordinate loan has been assumed to be 12% p.a.

11.1.6. Other assumptions

1. The land value has been assumed to be INR 160 lacs per acre. A lease rental of 3% of the land value (increasing with CPI) per annum has been assumed to be paid by the airport operator to the Authority (YEIDA or Department of Civil Aviation, Government of UP, as the case may be). However, a moratorium of 10 years from COD has been assumed for the lease rentals.
2. Cost of equity for the purpose of WACC / fair rate of return calculations has been taken as 16%
3. Non aeronautical revenue profile is expected to follow the profile observed at IGI airport. However, a stabilization period of four years has been taken for non-aeronautical revenues to align with IGI's profile
4. Revenue of the airport operator from Cargo, Ground Handling, Fuel throughput, CUTE charges has been assumed to be categorized as aeronautical revenue as per latest AERA rulings. The revenue from these services to the airport operator has been assumed through revenue share, rentals and royalties.
5. The real capital cost have been estimated in 2017-18 prices. The nominal prices include inflation and capitalization of IDC.
6. The financial close has been assumed to happen by 31 March 2019
7. The construction for phase 1 is assumed to start from April 2019
8. Each phase of construction is expected to be for 36 months (refer capital expenditure chapter and capex profiling section)
9. The average salary per full time employee at the airport in 2017-18 prices is assumed to be around INR 13.5 lacs p.a. This is based on the average salary expenses observed at various airports including private / PPP airports in India
10. Under hybrid till, the aggregate revenue requirement (ARR) considered the RAB and corresponding operating costs, depreciation and tax for aeronautical assets. Accordingly, benchmarks based on segregation percentage adopted at various airports in India have been used for segregating aeronautical and non-aeronautical assets, operating revenue and operating cost. Please refer to Annexure - "Detailed list of assumptions" for more information.
11. A five year moratorium from COD on revenue share has been assumed to enable the project to service its debt in the first phase.

11.2. Key outcomes of the financial assessment

With the above set of assumptions for the base case, this section presents the key outcomes of the financial assessment.

11.2.1. Nominal Capital investment and phasing

The conceptual plan laid out the capital layout in 2017-18 prices. The following table compares the real and nominal capital investment (including IDC capitalization) for different phases of the airport development:

Table 44: Real and nominal capital investment (including IDC capitalization) for different phases

Values in INR Crores	Base CapEx (Real) in 2017-18 prices	Final CapEx Incl. IDC (Nominal) including inflation and IDC
Construction - Phase 1	3,754	4,588
Construction - Phase 2	3,537	5,983
Construction - Phase 3	4,079	8,415
Construction - Phase 4	4,384	10,575
Total Construction Costs	**15,754**	**29,560**

The capital investment outlay in the initial phase of construction is expected to be around INR 4600 crore (in nominal terms including IDC capitalization). Overall, over the four phases of development, the total nominal value of investment is expected to be around INR 29600 crores. The base capex without IDC capitalization for all the phases together is working out to be around INR 15750 crore.

The investment phasing based on the traffic trigger assumptions is presented in the following table:

Table 45: Investment phasing based on the traffic trigger

Phasing of Capex	Year of Trigger
Construction phase 1 start date	2019-20
Construction phase 1 end date	2021-22
Construction phase 2 start date	2027-28
Construction phase 2 end date	2029-30
Construction phase 3 start date	2032-33
Construction phase 3 end date	2034-35
Construction phase 4 start date	2036-37
Construction phase 4 end date	2038-39

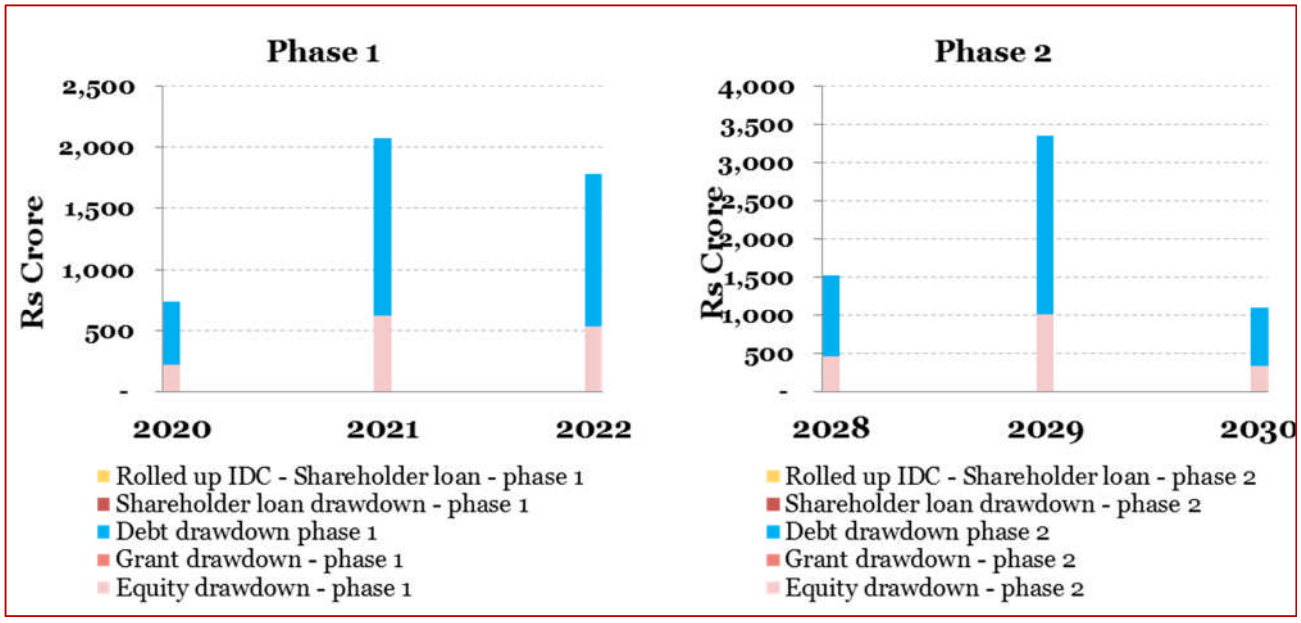
11.2.2. Means of Finance

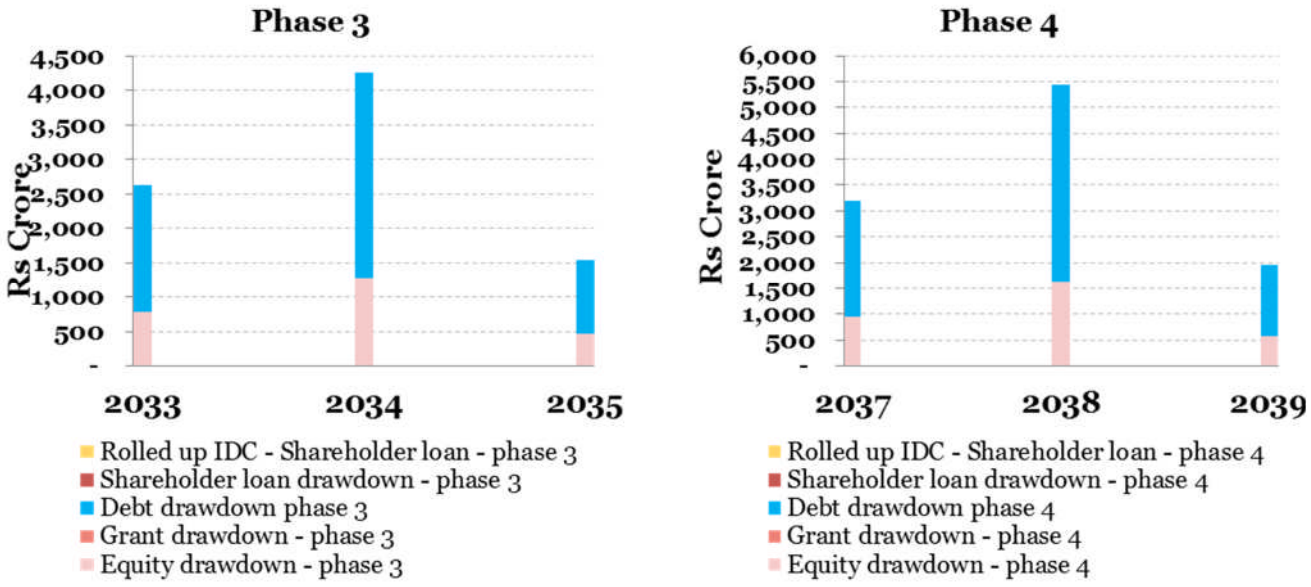
As discussed above, for the first phase of development the debt equity ratio has been assumed to be 70:30. Following table shows the means of financing for the project including phase wise financing:

Table 46 – Means of Financing for Jewar airport

Equity drawdown	*8,868*	*Crore INR*	*30.00%*
Grant drawdown	*-*	*Crore INR*	*-*
Total debt drawdown	*20,692*	*Crore INR*	*70.00%*
Shareholder loan drawdown	*-*	*Crore INR*	*-*
Shareholder loan IDC Rolled up	*-*	*Crore INR*	*-*
Total sources of fund	*29,560*	*Crore INR*	*100.00%*
Financing cost	*3,095*	*Crore INR*	*10.47%*
Capital costs	*26,465*	*Crore INR*	*89.53%*
DSRA pre-funding amount	*-*	*Crore INR*	*-*
Cash transferred to cash balance	*0*	*Crore INR*	*0.00%*
Upfront Fee premium to Authority	*-*	*Crore INR*	*-*
Shareholder loan IDC Rolled up	*-*	*Crore INR*	*-*
Total Project Costs	*29,560*	*Crore INR*	*100.00%*

Phase wise means of financing and application of funds

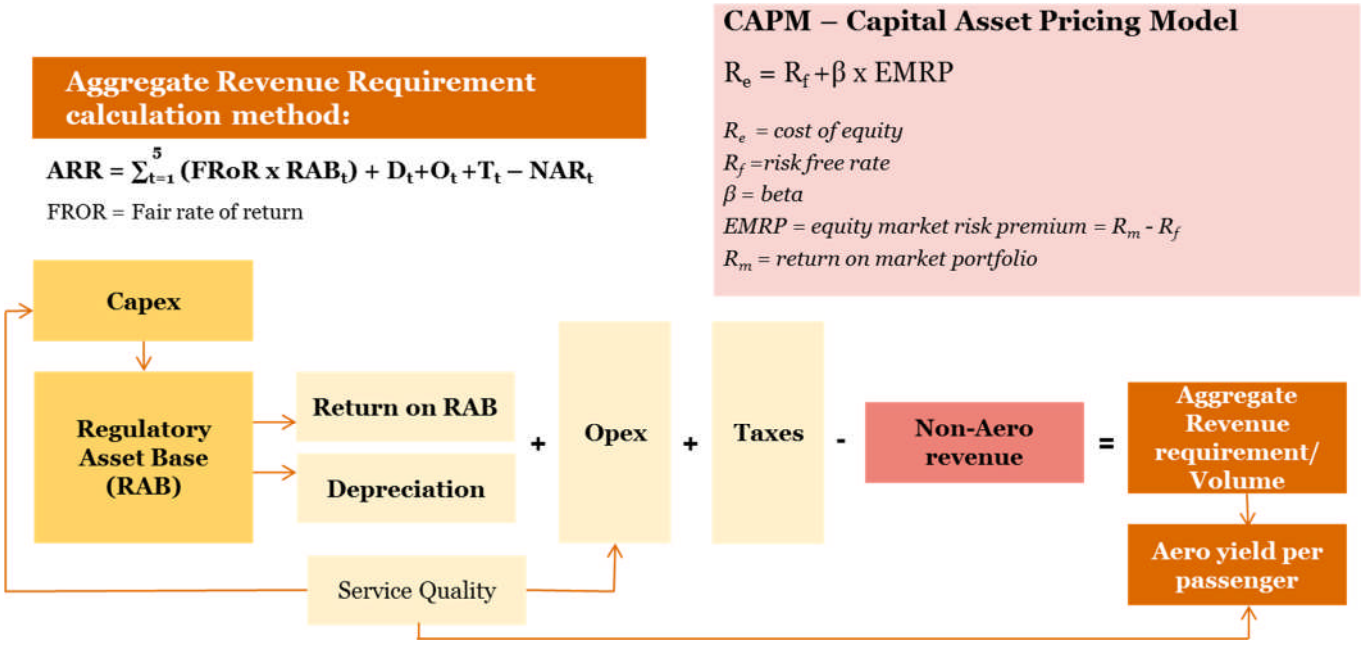




11.2.3. Economic Regulation and tariff card

As per the existing regulatory scenario as on March 2018 in India, a hybrid till cost plus approach has been adopted in determining the tariffs for the proposed airport at Jewar. For hybrid till, 30% cross subsidization by non-aeronautical revenue has been considered.

Figure 84: Regulatory Regime for tariff determination in India



The multi – year tariff card has been prepared based on the above economic regulation for each control period for five years, as highlighted in the following tables:

11.2.3.1. Yield projected for Jewar airport

11.2.3.1.1. Initial tariff card

Following tables reflect the "initial tariff card" for the various control periods as per the regulatory tariff determination methodology. It may be noted that the Landing, housing, parking and other charges in the actual tariff card may be levied in terms of Maximum Takeoff Weight (MTOW) and other parameters. Accordingly, while the revenues from Landing, housing, parking etc. has been calculated based on MTOW for various aircraft categories and aircraft projections, the tariff card has been converted into INR per pax for ease of understanding.

TARIFF CARD - CONTROL PERIOD 1					
All values in INR per passenger	2023	2024	2025	2026	2027
Input based Yield	1,257	1,308	1,360	1,414	1,471
Ground handling Revenue	28	29	30	31	33
Cargo handling Revenue	157	160	172	174	168
Fuel Throughput Revenue	37	39	39	40	41
Other Aeronautical Revenue	3	3	3	4	4
LPH Charges	102	107	113	115	122
User Development Fee	930	970	1,003	1,050	1,103
Total Yield Realised	1,257	1,308	1,360	1,414	1,471

TARIFF CARD - CONTROL PERIOD 2					
All values in INR per passenger	2028	2029	2030	2031	2032
Input based Yield	636	661	687	715	743
Ground handling Revenue	34	35	37	38	40
Cargo handling Revenue	151	139	134	118	116
Fuel Throughput Revenue	41	42	43	44	45
Other Aeronautical Revenue	4	4	4	4	4
Landing / Housing / Parking Charges	124	129	137	142	146
User Development Fee	281	311	333	368	391
Total Yield Realised	636	661	687	715	743

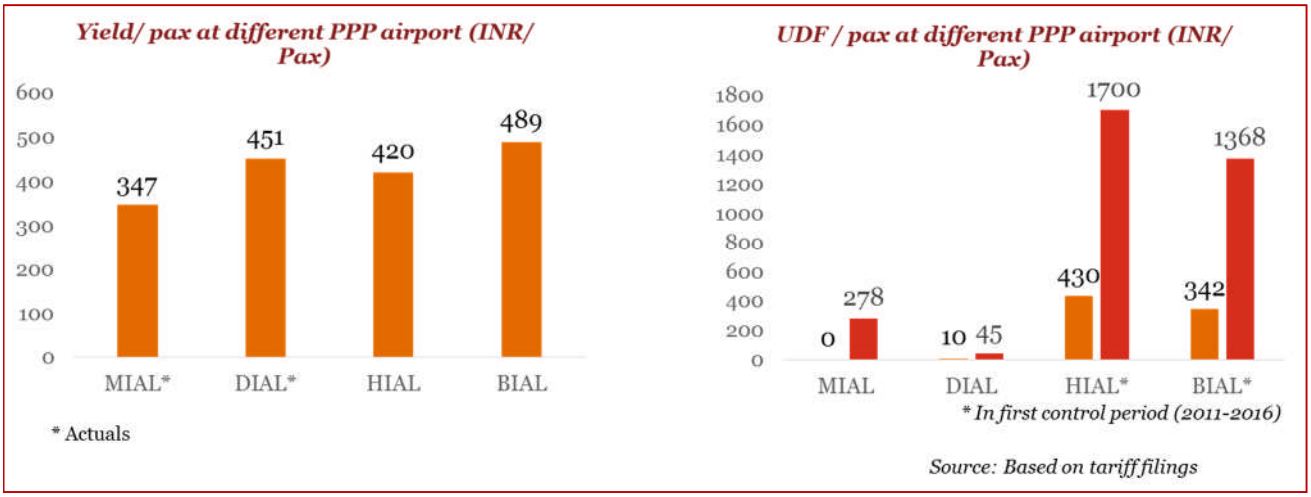
TARIFF CARD - CONTROL PERIOD 3					
All values in INR per passenger	2033	2034	2035	2036	2037
Input based Yield	738	767	798	830	863
Ground handling Revenue	41	43	45	47	48
Cargo handling Revenue	112	113	115	112	111
Fuel Throughput Revenue	47	48	50	52	54
Other Aeronautical Revenue	4	4	4	5	5
Landing / Housing / Parking Charges	154	160	170	178	188
User Development Fee	380	398	412	437	457
Total Yield Realised	738	767	798	830	863

TARIFF CARD - CONTROL PERIOD 4					
All values in INR per passenger	2038	2039	2040	2041	2042
Input based Yield	818	851	885	920	957
Ground handling Revenue	50	52	55	57	59
Cargo handling Revenue	109	112	115	118	121
Fuel Throughput Revenue	56	58	60	62	65
Other Aeronautical Revenue	5	5	5	6	6
Landing / Housing / Parking Charges	198	208	219	231	242
User Development Fee	399	415	431	447	465
Total Yield Realized	818	851	885	920	957

TARIFF CARD - CONTROL PERIOD 5					
All values in INR per passenger	1	2	3	4	5
Input based Yield	752	782	813	846	880
Ground handling Revenue	61	64	66	69	72
Cargo handling Revenue	125	127	132	142	155
Fuel Throughput Revenue	67	70	72	75	78
Other Aeronautical Revenue	6	6	6	7	7
Landing / Housing / Parking Charges	254	266	280	291	297
User Development Fee	239	249	256	261	270
Total Yield Realised	752	782	813	846	880

It may be noted from the above initial tariff card that the UDF per passenger for the first control period is in the range of INR 930 to INR 1100. It may be noted that the proposed green field airport at Jewar would be in competition with the existing IGI airport in Delhi. Further, a quick look at the latest yield and UDF approved by AERA reveals that the UDF arrived from the regulatory methodology would not be able to attract airlines and passenger traffic in the initial years.

Figure 85 – Yield and UDF at PPP airports in India



Accordingly, the tariff card has been revised, assuming that the airport operator in the first control period would be able to recover a yield of approximately INR 800 per passenger in order to bring the UDF under INR 500 per passenger and still able to service its debt. It has been further assumed that the airport operator would be able to true up the balance yield in the next control period (as has been observed in case of some of the airports in India).

11.2.3.1.2. Revised Tariff Card

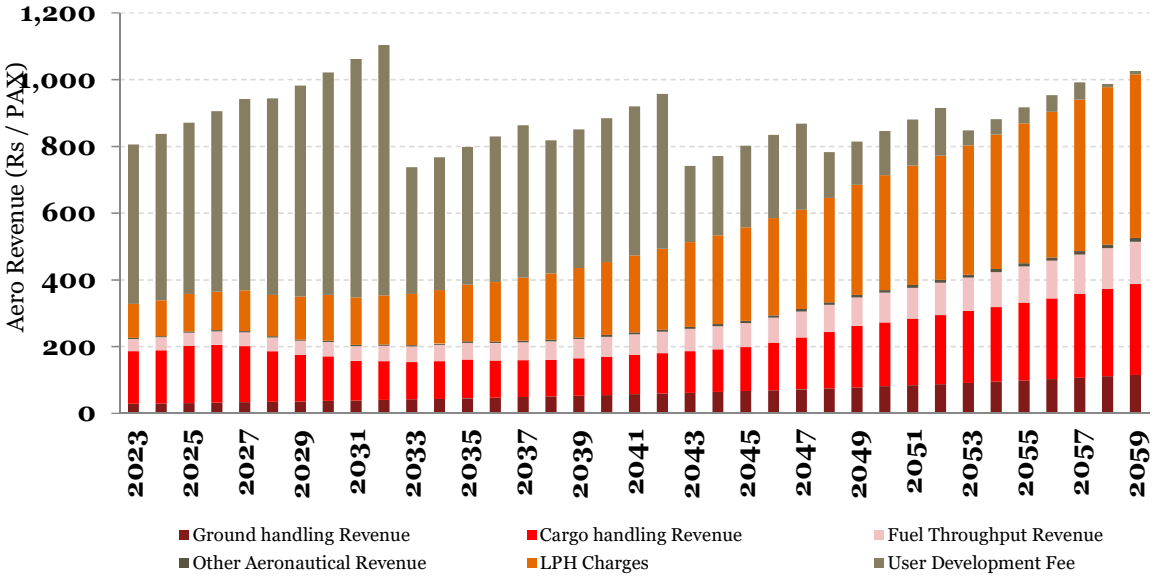
Following tables shows the revised tariff cards for the first two control periods in line with the discussion above:

REVISED TARIFF CARD - CONTROL PERIOD 1					
All values in INR per passenger	2023	2024	2025	2026	2027
Input based Yield	805	837	871	906	942
Ground handling Revenue	28	29	30	31	33
Cargo handling Revenue	157	160	172	174	168
Fuel Throughput Revenue	37	39	39	40	41
Other Aeronautical Revenue	3	3	3	4	4
LPH Charges	102	107	113	115	122
User Development Fee	478	499	513	541	574
Total Yield Realised	805	837	871	906	942

REVISED TARIFF CARD - CONTROL PERIOD 2					
All values in INR per passenger	2028	2029	2030	2031	2032
Input based Yield	944	982	1,021	1,062	1,104
Ground handling Revenue	34	35	37	38	40
Cargo handling Revenue	151	139	134	118	116
Fuel Throughput Revenue	41	42	43	44	45
Other Aeronautical Revenue	4	4	4	4	4
Landing / Housing / Parking Charges	124	129	137	142	146
User Development Fee	590	632	667	715	752
Total Yield Realised	944	982	1,021	1,062	1,104

The tariff cards for the remaining control period would remain same. Following graph summarizes the aeronautical yield per pax for the full concession period for Jewar airport:

Figure 86 – Aeronautical Yield breakup for Jewar airport based on revised tariff card



11.2.4. Financial Viability assessment

With the above tariff card and other relevant parameters like operating costs, non-aeronautical revenues, capital expenditure and means of financing discussed in the relevant chapters and sections, following sub section assesses the financial viability from the perspective of –

1. Ability to service debt – Analysis of the coverage ratios
2. Returns on investment generated from the airport

11.2.4.1. Coverage ratios – Ability to service debt

The first aspect of the bankability and financial viability of the project is to assess if the project is capable of servicing its debt under standard terms and conditions of the commercial banks. These are assessed through various coverage ratios, as shown by the financial indicators in the following table:

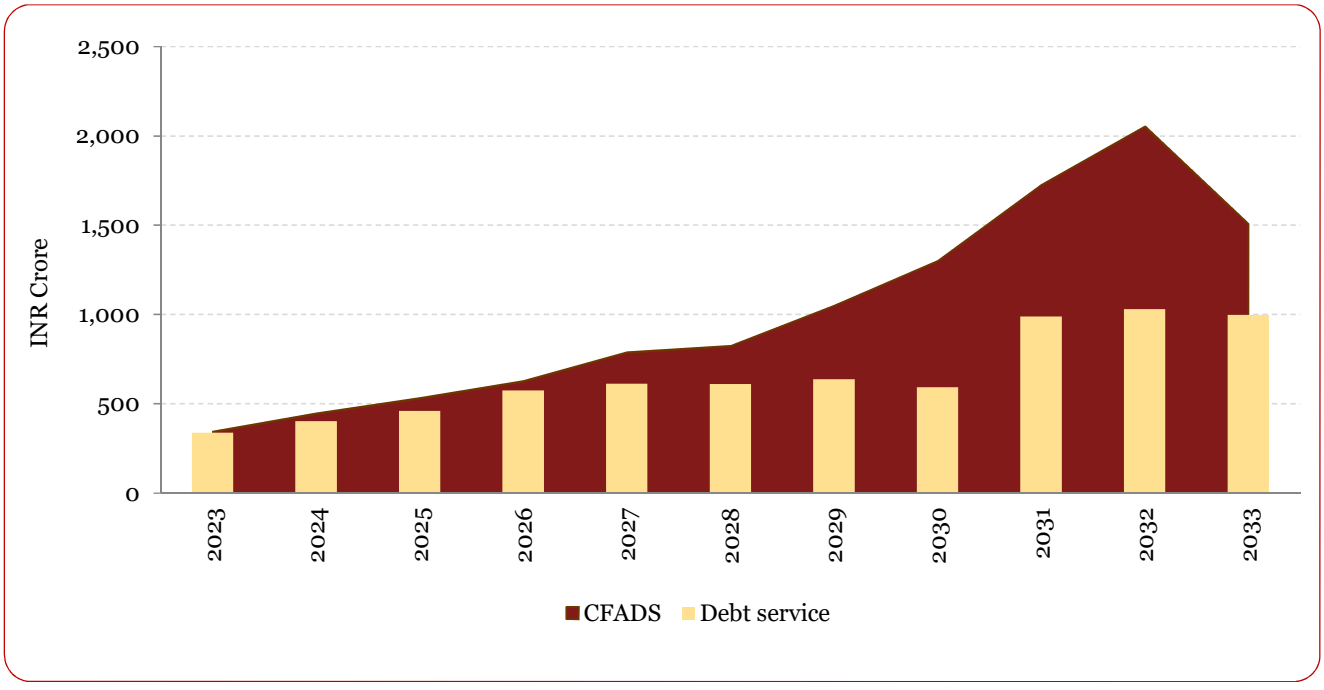
Table 47: Coverage ratios

FINANCING INDICATORS		
Simple average DSCR	2.1286	ratio
Minimum DSCR	1.0899	ratio
Minimum DSCR date	31 Mar 2026	date
Simple average forward looking ADSCR	2.1677	ratio

FINANCING INDICATORS		
Minimum forward looking ADSCR	1.0899	ratio
Minimum forward looking ADSCR date	31 Mar 2025	date
Simple average backward looking ADSCR	2.1286	ratio
Minimum backward looking ADSCR	1.0899	ratio
Minimum backward looking ADSCR date	31 Mar 2026	date
Simple average LLCR	8.2752	ratio
Minimum LLCR	2.5407	ratio
Minimum LLCR date	31 Mar 2040	date

It may be noted from the above figure that the coverage ratios are well above 1, meaning that the project cash flows are sufficient meet the debt service requirements. Following chart compares the year on year Cash Flow Available for Debt Service (CFADS) with the debt service requirements for the first ten years of operation:

Figure 87 – CFADS vs Debt Service



It may be noted from the chart above that CFADS are enough to service the debt for the first 10 years, which are the most critical years considered for the viability of a Greenfield airport.

11.2.4.2. Returns on investment

The internal rate of returns have been calculated based on the cash flow generated from the project. The equity rate of return for the equity investors has been worked out to be around 16.3% while the project IRR has been assessed to be around 14.4%.

11.2.4.3. Sensitivity Analysis

This section would assess the volatility of the results of the base case scenario if certain important assumptions are changed. The assessment would also highlight the factors on which adequate diligence must be undertaken to assess the financial viability.

The sensitivity assessment has been accordingly undertaken on the following parameters:

1. **Traffic**: An optimistic and pessimistic traffic scenario has been developed under the following key assumptions:

    a. Optimistic case:

    i. Palwal Khurja Expressway gets ready before operations at Jewar airport commences. This will enable better connectivity to Ghaziabad resulting in more traffic at Jewar airport

    ii. With the augmentation of shale gas exploration, several research and think tanks forecasts that the crude oil prices would stablises at USD 50 per barrel. Such a scenario would be beneficial for the aviation industry as resulting reduced airlines prices may induce higher traffic in the hinterland itself.

    iii. Passengers from Punjab and Haryana and other parts of non-core hinterland(non-core hinterland beyond 150 km) will come to Jewar using Eastern and Western Peripheral Expressway

    Likewise, certain triggers may result in low traffic; accordingly forms the basis for the pessimistic case.

    b. Pessimistic traffic scenario

    i. Metro and RRTS connectivity may not be ready before 2026-27 (when IGI airport's traffic spillover is expected to commence)

    ii. Palwal-Khurja Expressway does not come up (no natural flow of traffic from Faridabad, Bareilly, Meerut)

Table 48: Sensitivity and demand variation

	2022 to 2023	2023 to 2024	2024 to 2025	2025 to 2026	2029 to 2030	2034 to 2035	2039 to 2040	2044 to 2045	2049 to 2050
Domestic Passenger (million)									
Low case	3.27	3.57	4.10	4.44	6.35	11.48	26.14	41.62	61.52
High case	5.84	7.52	10.06	12.47	20.75	31.73	49.41	67.03	88.65
International Passenger (million)									
Low case	0.19	0.21	0.24	0.26	0.66	2.35	4.72	7.22	9.86
High case	0.21	0.28	0.62	1.33	3.24	6.12	10.51	13.29	16.18

2. **Delay in construction**: Given the commitment of the state government of Uttar Pradesh, the base case assumes that land acquisition would be undertaken with FY 19. However, in case of unforeseen circumstances, in case there is a delay in acquisition of key parcels of land; this may impact the financial outcomes.

3. **Change in capital cost**: Likewise, there may be increase/decrease in capital cost owing to inflation and other reasons

4. **Inadequate realization of non-aeronautical revenues**: Non aeronautical revenues play a significant role in the deciding the revenue share to the Authority. Accordingly, a sensitivity assessment on this parameter has been undertaken to assess its impact on the results of the base case.

The sensitivity analysis has been undertaken assuming a bidder has quoted a particular revenue share with base case assumptions. With this fixed revenue share, this assessment studies the impact on the parameters like UDF, Cash Short fall to debt service, minimum DSCR and equity IRR due to change in the base case assumptions, as discussed above. Following table highlights the results of this sensitivity analysis:

Table 49: Sensitivity and variation of parameters

Scenarios	Regulatory Yield per passenger for first year of 1st CP	Yield considered in first year of 1st CP	Cash shortfall (INR crore)	Minimum DSCR	Equity IRR
Base Case	1257	805	Nil	1.09	16.3%

Scenarios	Regulatory Yield per passenger for first year of 1st CP	Yield considered in first year of 1st CP	Cash shortfall (INR crore)	Minimum DSCR	Equity IRR
Optimistic traffic case	848	805	Nil	1.23	18.9%
Pessimistic traffic case	1788	805	672	0.65	14.9%
Base case traffic with one year of delay in construction	1029	805	Nil	1.15	15.4%
Increase in capital cost by 10% from base case	1284	805	30	1.0	15.6%
Decrease in capital cost by 10% from base case	1087	805	Nil	1.22	17.6%
Decrease in non-aeronautical revenue by 10% from base case	1177	805	Nil	1.08	14.9%

11.2.4.4. Conclusion

1. The project appears to be self-sustainable and generate adequate equity returns of around 16% for the equity investors
2. The project appears to be bankable with all the coverage ratios above the desired threshold along the concession period
3. The UDF and yield expected for the project is within the reasonable range based on the revised tariff card assessment. Accordingly, in-spite of Jewar Airport being the second airport in the NCR region, the issues of competitive pricing pressure appears to be limited
4. The sensitivity assessment reflects limited impact on the IRR due to change in critical assumptions of the base case
5. Overall, the project appears to be financially viable under the assumptions made in the base case

12. Economic IRR

As highlighted in the sections above, in order to attract traffic at Jewar airport, government needs to undertake several connectivity development project. One of the most critical and costly project includes development of Rapid Rail Transit System (RRTC) based connectivity to Jewar.

Undertaking such investment needs justification from an economic point of view. Airports constitute important infrastructure components for a country/region as they form integral nodes enabling rapid access to the world's transportation network. They facilitate movement of people across countries and cultures, provide access to goods and services across global markets, generate trade and tourism, and forge geo-political links between various countries. Consequently, they have significant contribution in the socio-economic benefits and sustainable development of economy and region.

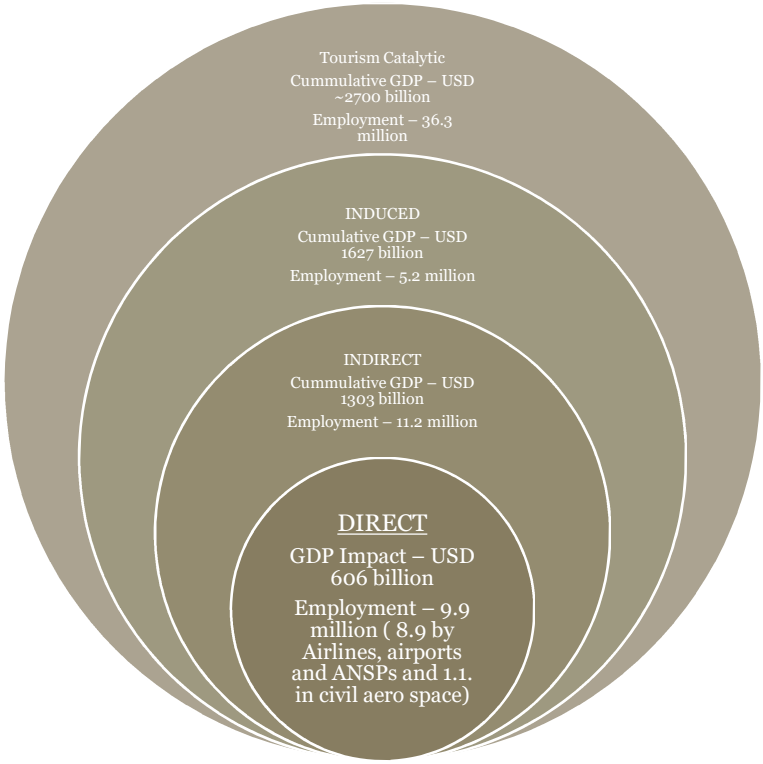
The direct benefits are for the customers, such as passengers or air cargo shippers, who use the air transport service primarily for travel and transportation. Apart from that, the integrated network created among global cities and markets generates benefits by enabling foreign investments, forming business clusters and resulting in other wider economic benefits.

Generally, the economic footprint of the airport sector is measured by its contribution to GDP, jobs and tax revenues generated by the sector and its supply chain.[14] However, the economic value created by the sector goes beyond the value captured by these measures.[15] This highly symbiotic relationship results in economic and employment multipliers in the economy of the region.

[14] Economic Benefits from Air Transport in India, Oxford Economics, https://www.iata.org/policy/Documents/Benefits-of-Aviation-India-2011.pdf

[15] The Economic Benefits of Aviation and Performance in the Travel & Tourism Competitiveness Index ,http://www3.weforum.org/docs/TTCR/2013/TTCR_Chapter1.4_2013.pdf

Figure 88: Economic benefit of airport infrastructure



Source: Aviation: Benefits Beyond Borders, April 2014

The sector also results generating potential social benefits, such as, broadening people's leisure and cultural experiences via wide choice/ affordable access to destinations across the globe, providing only means of transportation to remote areas, promoting social inclusion, facilitating swift delivery of medical supplies and humanitarian aid during emergencies, generating jobs and employment opportunities, etc.[16]

The air transport industry supports 62.7 million jobs globally, with airlines, airports and air navigation service providers (ANSPs) employing 8.9 million people. Almost 36.3 million additional direct and indirect jobs are created through air transport's catalytic impact on tourism, thus improving living standards and alleviating poverty.1718

[16] Aviation Benefits Beyond Borders, http://www.iata.org/pressroom/facts_figures/fact_sheets/Documents/fact-sheet-economic-and-social-benefits-of-air-transport.pdf
[17] Aviation Benefits Beyond Borders, http://www.iata.org/pressroom/facts_figures/fact_sheets/Documents/fact-sheet-economic-and-social-benefits-of-air-transport.pdf
[18] The above figures do not include the other economic benefits of aviation like existence of jobs and industries that depends solely on aviation transport. Likewise, the induced economic multiplier impact does not take into consideration the intrinsic value or the efficiency that aviation brings into the business

Not surprisingly, most of the countries have laid emphasis on optimal provision of airport and related infrastructure in their respective national objectives. Table 50 highlights the GDP and employment multiplier observed in different countries for aviation:

Table 50:GDP and Employment multiplier by country

Country	Employment Multiplier	GDP Multiplier
China	*2.86*	*1.9*
India	*2.58*	*1.6*
Indonesia	*2.49*	*1.5*
Thailand	*2.49*	*8.4*
Malaysia	*2.17*	*13.7*
Hong Kong	*2.31*	*2.9*
Taiwan	*2.48*	*2.1*
Vietnam	*2.65*	*15.9*
Sri Lanka	*2.19*	*1.7*
Bangladesh	*2.28*	*1.0*
Myanmar	*2.20*	*2.5*

The economic IRR assessment accordingly considers 1.6 as the multiplier impact for the economy of UP and Jewar hinterland. Following are other assumptions used for economic IRR calculations:

1. The incremental capital output ratio (ICOR) for the region has been assumed to be 4. This is in line with the ICOR observed for India
2. General inflation and capital cost inflation is aligned with the financial analysis undertaken above (i.e. 4% year on year)
3. The discount rate for calculating NPV has been assumed to be 7.5%. This is in line with Government of India's 10 year bond yield
4. The interest rate for debt taken for RRTS and MRTS connectivity has been assumed to be 7.5% (generally these project secure multilateral funding with 2% interest rate but government needs to be bear the hedging cost of around 5%-6%)
5. The repayment period for loans taken for RRTS and MRTS is 20 years. This is in line with the loan provided by multilateral agencies. The loan also assumes moratorium of 2 years on principal repayment

6. Interest during construction is capitalized and added to the project cost
7. The debt: equity ratio has been assumed to be 60:40. This is in line with the loans secured for RRTS development in the region
8. The construction for RRTS and MRTS has been assumed to be six years. The construction for MRTC has been assumed to start from 2019 while the construction for RRTS has been assumed to start from 2022

The economic IRR calculations assumes benefits to the economy and government due to development of airport. Likewise, government needs to undertake investments in developing key connectivity infrastructure. The benefits and costs are discussed below:

A. Benefits to the economy and government due to construction of airport

a. Economic output with a multiplier of 1.6 due to investment at airport. In present value terms, this is estimated to be around INR 63,500 crores

b. Tax revenue to the government from the economic output: This has been assumed to be only 1% of the economic output. In present value terms, this comes out to be around INR 635 crore

c. The income from revenue share from the airport, in present value terms has been estimated to be around INR 4,175 crore

d. The tax revenue from airport, in present value term works out to be around INR 2100 crore

e. The lease rentals from the airports to the government, in present value terms, have been estimated to be around INR 1365 crore

B. Costs to be incurred by the government

a. Cost of land acquisition for Jewar airport – INR 4500 crore (approximate)

b. Developing connectivity through RRTS: A broad cost estimates based on benchmarks assesses this cost to be around INR 14000 crore[19] in present value terms. In nominal terms including impact of inflation and cost of servicing debt over the next 20 years post construction, the cost works out to be around INR 29,000 crore

c. Initial estimates for developing metro connectivity between Greater Noida and Jewar suggest INR 3,500 crore in present value terms. In nominal terms including impact of

[19] This cost estimates is based on basic benchmarks. A detailed technical study would need to be undertaken to arrive at the exact cost

inflation and cost of servicing debt over the next 20 years post construction, the cost works out to be around INR 9,000 crore

d. Cost of developing road connectivity:

   i. 75 m road parallel to airport boundary length 4.84 km – INR 23 crore

   ii. 130 m road connecting Noida to Greater Noida length 25 km – INR 125 crore

   iii. 60 m wide road parallel to Yamuna Expressway length 30 km – INR 90 crore

C. Economic IRR

Taking the above into consideration, the economic IRR for the project has been estimated to be 23 percent. Kindly refer to the annexure for detailed assessment of the economic IRR. In NPV terms, the government is expected to have a positive NPV of INR 49,000 crore.

12.1. Conclusion

1. The project appears to be self-sustainable and generate adequate equity returns of around 16 percent for the equity investors
2. The project appears to be bankable with all the coverage ratios above the desired threshold along the concession period
3. The UDF and yield expected for the project appears to be within the reasonable range based on the revised tariff card assessment. Accordingly, in-spite of Jewar Airport being the second airport in the NCR region, the issues of competitive pricing pressure appears to be limited
4. Overall, the project appears to be financially viable under the assumptions made in the base case
5. The project reflects decent economic returns to the region, with an economic IRR of 23 percent and positive NPV of INR 49000 crore.

Appendix A. - Hinterland

A.1. Districts in the hinterland (GDP and population)

Table 51: Information on districts in the core hinterland

Name of District	Name of State	GDP (2010-11, INR lakhs)	Population (2011)	GDP per capita (INR lakhs)
Multiple	NCT of Delhi	43925990	16787941	2.62
Saharanpur	Uttar Pradesh	2278120	3464228	0.66
Muzaffarnagar	Uttar Pradesh	2638155	4143512	0.64
Bijnor	Uttar Pradesh	2377450	3682713	0.65
Baghpat	Uttar Pradesh	1003464	1303048	0.77
Meerut	Uttar Pradesh	2704905	3443689	0.79
Ghaziabad	Uttar Pradesh	3471394	4681645	0.74
Amroha	Uttar Pradesh	1183887	1840221	0.64
Gautam Buddh Nagar	Uttar Pradesh	3310821	1648115	2.01
Aligarh	Uttar Pradesh	2076739	3673849	0.57
Bulandshahar	Uttar Pradesh	2388801	3499171	0.68
Rampur	Uttar Pradesh	1156857	2335819	0.50
Moradabad	Uttar Pradesh	2517883	4773138	0.53
Buduan	Uttar Pradesh	1786862	3681896	0.49
Kanshiram Nagar	Uttar Pradesh	369831	1436719	0.26
Mathura	Uttar Pradesh	1661258	2541894	0.65
Etah	Uttar Pradesh	1207864	1774480	0.68
Hathras	Uttar Pradesh	968792	1564708	0.62
Agra	Uttar Pradesh	2717111	4418797	0.61
Bareilly	Uttar Pradesh	2353064	4448359	0.53
Haridwar	Uttarakhand	2434866	1890422	1.29
Karnal	Haryana	2242244	1505324	1.49
Kaithal	Haryana	1321012	1074304	1.23

Name of District	Name of State	GDP (2010-11, INR lakhs)	Population (2011)	GDP per capita (INR lakhs)
Jind	Haryana	1636425	1334152	1.23
Hisar	Haryana	2666545	1743931	1.53
Bhiwani	Haryana	1788603	1634445	1.09
Rohtak	Haryana	1340614	1061204	1.26
Panipat	Haryana	2490466	1205437	2.07
Sonipat	Haryana	2025868	1450001	1.40
Jhajjar	Haryana	1237150	958405	1.29
Mahindergarh	Haryana	826652	922088	0.90
Rawari	Haryana	1579607	900332	1.75
Gurgaon	Haryana	6640683	1514432	4.38
Faridabad	Haryana	4904081	1809733	2.71
Jhunjhunu	Rajasthan	1361065	2137045	0.64
Alwar	Rajasthan	3176454	3674179	0.86
Sikar	Rajasthan	1671879	2677333	0.62
Bharatpur	Rajasthan	1467717	2548462	0.58

Note: GDP figures are at 2017 price levels. Source: NITI Aayog, Census 2011, PwC analysis

Appendix B. - IGI Airport

B.1. Traffic patterns (domestic)

Table 52: Breakup of IGIA's domestic traffic, by destination

Destination	Share in Delhi's domestic traffic (percentage)
MUMBAI	14.873%
BENGALURU	8.869%
KOLKATA	6.414%
PUNE	5.512%
HYDERABAD	5.310%
CHENNAI	5.147%
AHMEDABAD	4.424%
LUCKNOW	4.218%
GOA	3.825%
PATNA	3.441%
SRINAGAR	2.970%
GUWAHATI	2.882%
AMRITSAR	2.351%
BAGDOGRA	2.159%
BHUBANESWAR	2.063%
KOCHI	2.013%
RANCHI	1.917%
VARANASI	1.815%
DEHRA DUN	1.676%
JAIPUR	1.586%
CHANDIGARH	1.566%
JAMMU	1.537%
INDORE	1.394%
NAGPUR	1.101%
RAIPUR	1.040%
LEH	1.031%
TRIVANDRUM	1.007%
UDAIPUR	0.975%
VADODARA	0.812%
SURAT	0.778%

Destination	Share in Delhi's domestic traffic (percentage)
BHOPAL	0.678%
VISAKHAPATNAM	0.635%
COIMBATORE	0.584%
JODHPUR	0.449%
VIJAYAWADA	0.337%
DHARAMSALA	0.280%
IMPHAL	0.272%
PORT BLAIR	0.230%
JABALPUR	0.222%
DIBRUGARH	0.208%
AURANGABAD	0.177%
MANGALORE	0.172%
MADURAI	0.143%
GAYA	0.107%
AGARTALA	0.105%
RAJKOT	0.103%
ALLAHABAD	0.095%
TIRUPATI	0.093%
DIMAPUR	0.055%
KULLU	0.050%
KOZHIKODE	0.047%
AIZAWL	0.040%
PANTNAGAR	0.032%
BHATINDA	0.029%
GWALIOR	0.024%
KHAJURAHO	0.024%
BIKANER	0.022%
SILCHAR	0.020%
JAISALMER	0.019%
BHUJ	0.014%
SIMLA	0.013%
LUDHIANA	0.012%
JORHAT	0.007%
AGRA	0.001%

Note: Data is for 2017

Source: DGCA

B.2. Traffic patterns (international)

Table 53: Breakup of IGIA's international traffic, by destination

Destination	Share in Delhi's international traffic (percentage)
DUBAI	13.438%
LONDON	6.586%
BANGKOK	5.974%
KATHMANDU	4.980%
SINGAPORE	4.584%
ABUDHABI	4.373%
HONG KONG	3.778%
DOHA	3.739%
FRANKFURT	2.988%
KUALALUMPUR	2.970%
MUSCAT	2.791%
AMSTERDAM	2.214%
MOSCOW	1.992%
PARIS	1.904%
KABUL	1.851%
TORONTO	1.802%
DAMMAM	1.665%
ISTANBUL	1.630%
BAHRAIN	1.607%
PEKING	1.548%
JEDDAH	1.485%
COLOMBO	1.459%
SHARJAH	1.452%
GUANGZHOU	1.429%
KUWAIT	1.279%
SEOUL	1.254%
NEWARK	1.245%
NEW YORK	1.212%
NARITA	1.204%
CHICAGO	1.111%
MUENCHEN	1.068%
RIYADH	1.006%
ZURICH	0.967%
DHAKA	0.768%

Destination	Share in Delhi's international traffic (percentage)
SAN FRANCISCO	0.709%
ADDIS ABABA	0.701%
BIRMINGHAM	0.690%
TOKYO	0.624%
HELNSKI	0.603%
SYDNEY	0.557%
ALMATY	0.535%
TASHKENT	0.533%
SHANGHAI	0.519%
MALPENSA	0.518%
MELBOURNE	0.448%
ROME	0.425%
PARO	0.384%
TAIPAE	0.363%
VIENNA	0.362%
MARUITIUS	0.358%
MADRID	0.298%
TEHRAN	0.293%
KUNMING	0.243%
MALE	0.231%
BISHKEK	0.210%
ASHGABAT	0.199%
BASRA	0.199%
MEDINA	0.169%
WASHINGTON, DC	0.095%
OSAKA	0.077%
KANDAHAR	0.070%
DUSHANBE	0.067%
STOCKHOLM	0.043%
LAHORE	0.037%
ASTANA	0.032%
RANGOON	0.030%
COPENHAGEN	0.012%
KARACHI	0.012%

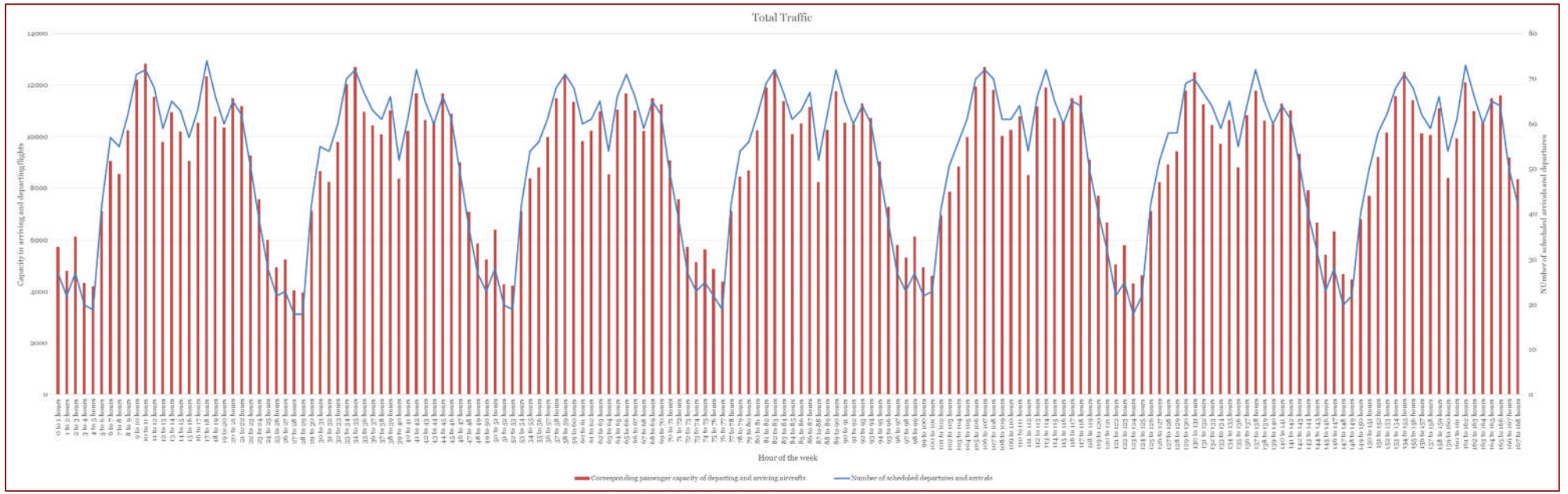
Note: Data is for 2016-17 (October to September)

Source: DGCA

B.3. ATM movement pattern at IGIA (scheduled operations)

B.3.1. Overall weekly movement

Figure 89: Air traffic movement pattern at IGIA (overall)

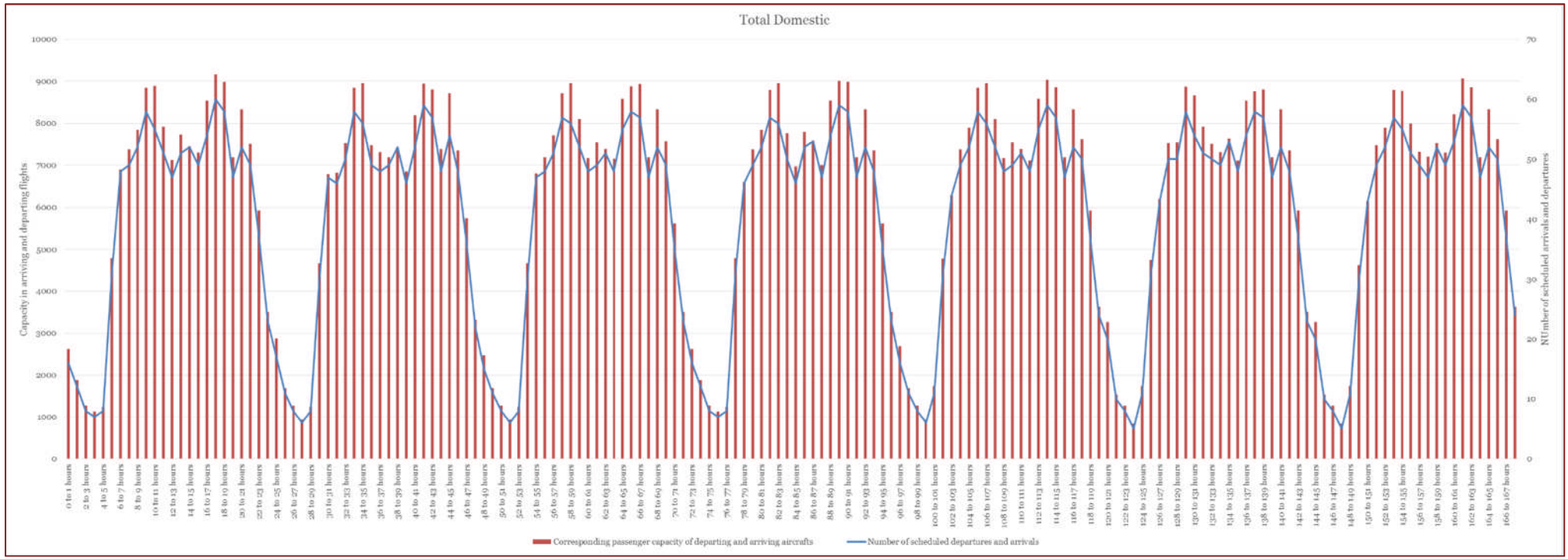


Note: 1 hour means 1 am on a Monday

Source: PwC analysis

B.3.2. Overall domestic movement

Figure 90: Air traffic movement pattern at IGIA (domestic)

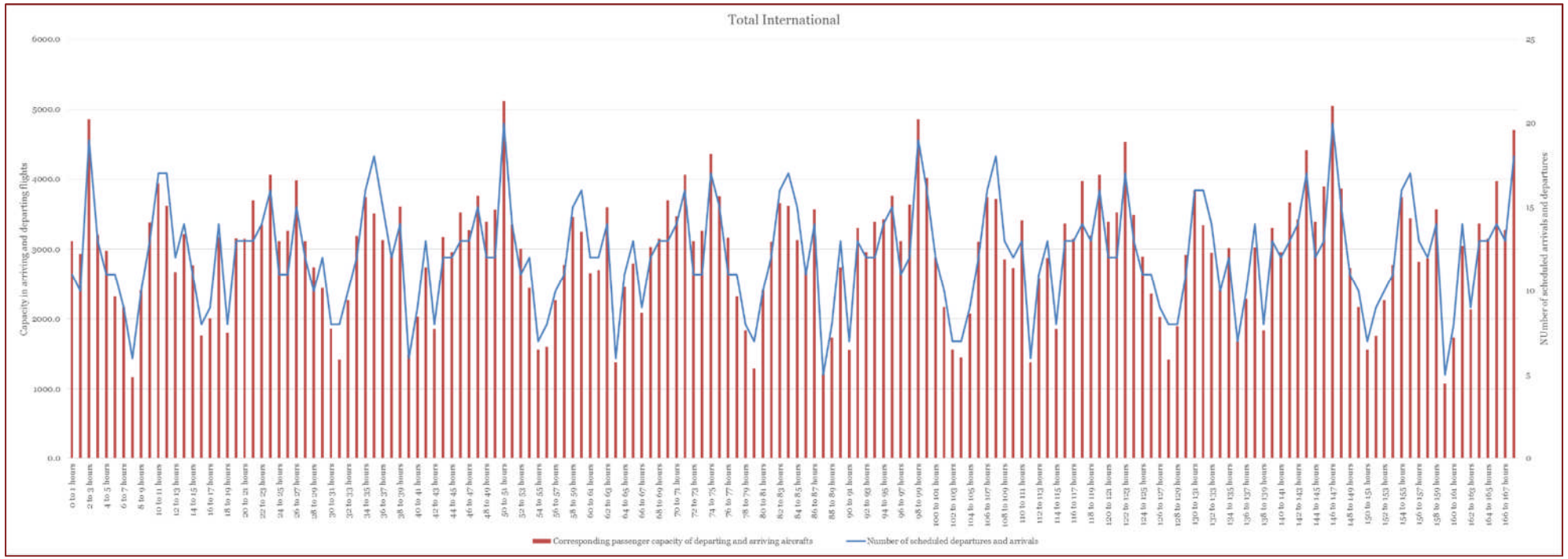


Note: 1 hour means 1 am on a Monday

Source: PwC analysis

B.3.3. Overall international movement

Figure 91: Air traffic movement pattern at IGIA (international)



Note: 1 hour means 1 am on a Monday

Source: PwC analysis

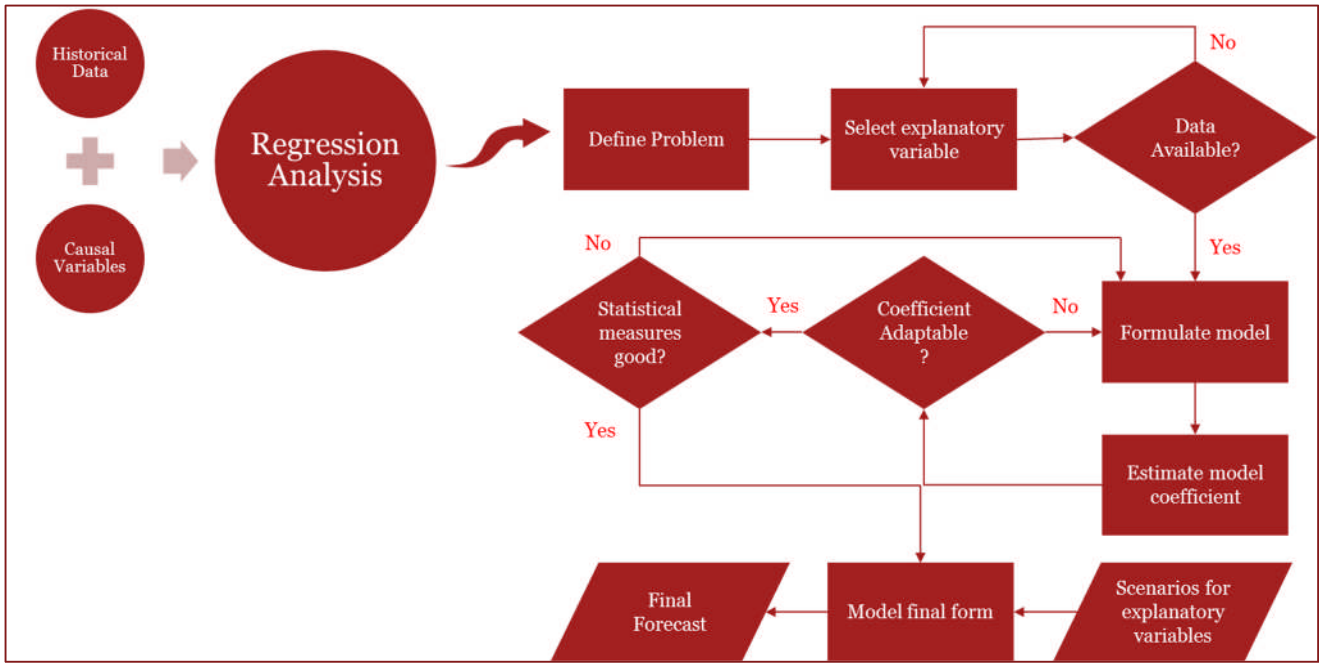
Appendix C. - Regression for traffic forecast

Reliable forecasts of civil aviation activity play a critical role in the planning process of States, airports, airlines, engine and airframe manufacturers, suppliers, air navigation service providers and other relevant organizations.

According to ICAO, It has been found that the demand for air travel is primarily determined by socio-economic variables such as income, demographics and the cost of air travel. World energy demand, supply and prices are critically important to both economic progress and the cost of air travel. GDP, the broadest available economic indicator, is used in this model to estimate the impact of economic, demographic and income factors. Airline yields can be used as a proxy for average airline fares, but the average fare is considered more appropriate or ideal.

Regression analysis is by far the most popular method of forecasting civil aviation demand. In regression analysis, the forecast is based not only on the historical values of the item being forecast but also on other variables that are considered to have a causal relationship. Multiple regression analysis takes into account more than a single explanatory variable, in contrast to the one variable used in simple regression analysis. Regression analysis estimates the coefficients on the basis of the least squares criterion, which requires that the line that is fitted to the sample data be such that the sum of the squares of the vertical deviations (distances) from the data points to the line be a minimum.

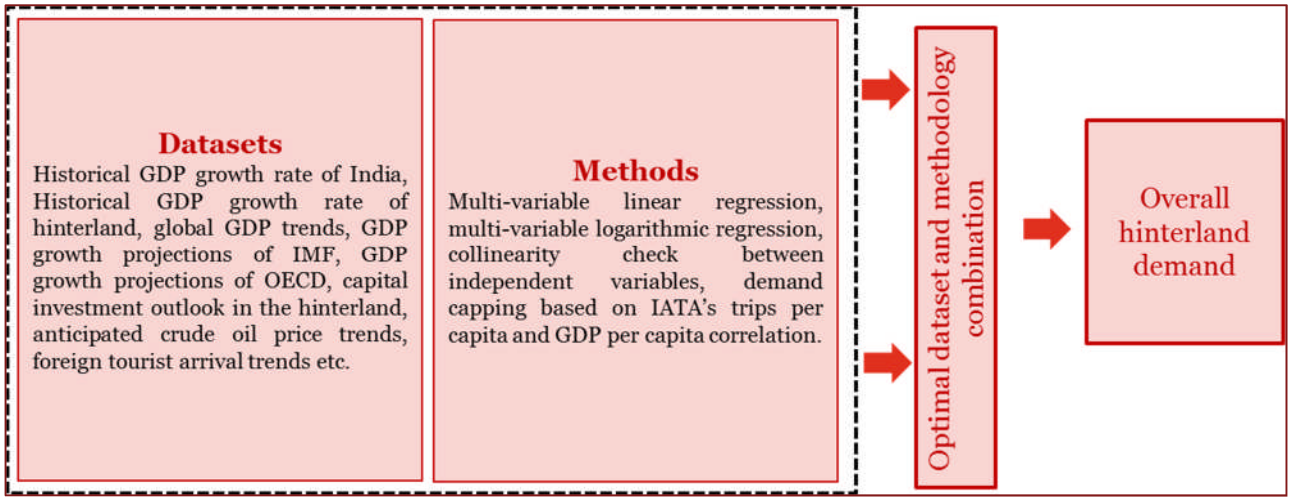
Figure 92: Traffic forecasting methodology, ICAO



Source: ICAO- Manual for Air Traffic Forecasting

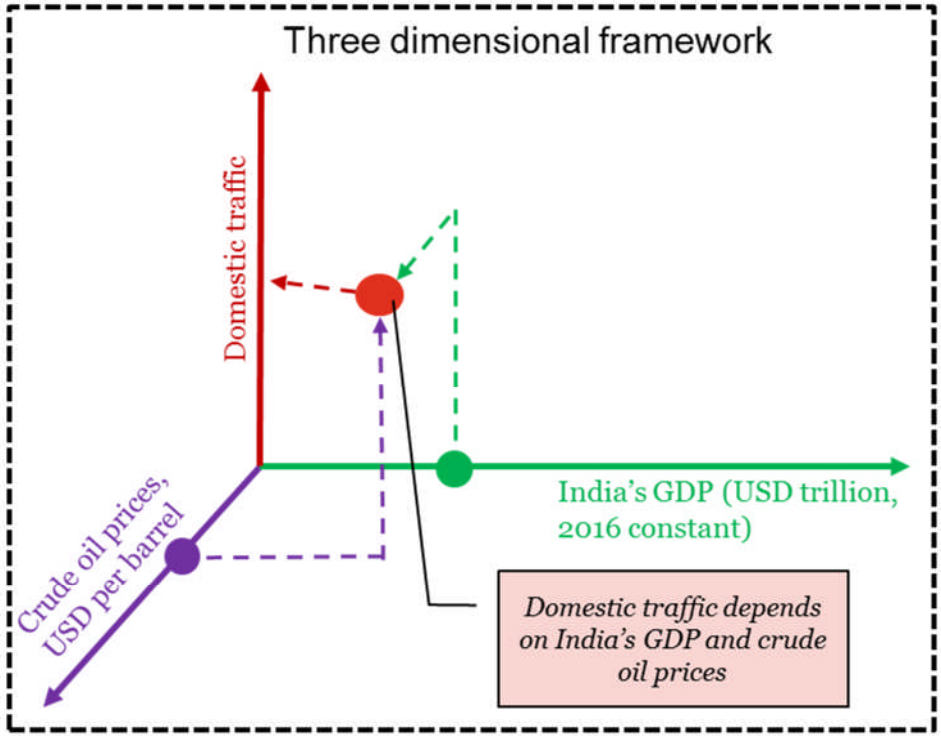
For this study, historical data, anticipated trends were tried on multiple mathematical models to determine overall hinterland demand. The most strongly correlated, reliable, and practical mathematical model was selected. Independent regression models were used for domestic and international traffic. The datasets used for analysis and the methods that were applied on them have been depicted in Figure 93.

Figure 93: Datasets and methods considered for regression



C.1. Regression for domestic traffic

Demand for domestic traffic was obtained as a function of GDP and crude oil prices



Regression equation:

Domestic passenger handling (in million)=
-11.251
+ 21.701*India's GDP
- 0.026*Crude Oil Prices

Positive coefficient for India's GDP: Traffic grows as GDP grows

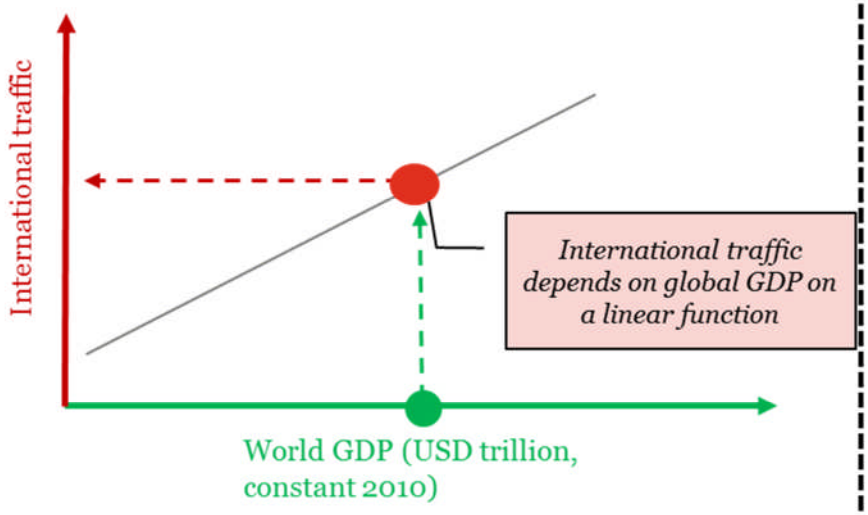
Negative coefficient for crude oil: Traffic declines as crude oil prices increase

Strong statistical correlation: R squared value is 0.97

C.2. Regression for international traffic

Demand for international traffic was obtained as a function of global GDP growth

Two dimensional framework



Regression equation:

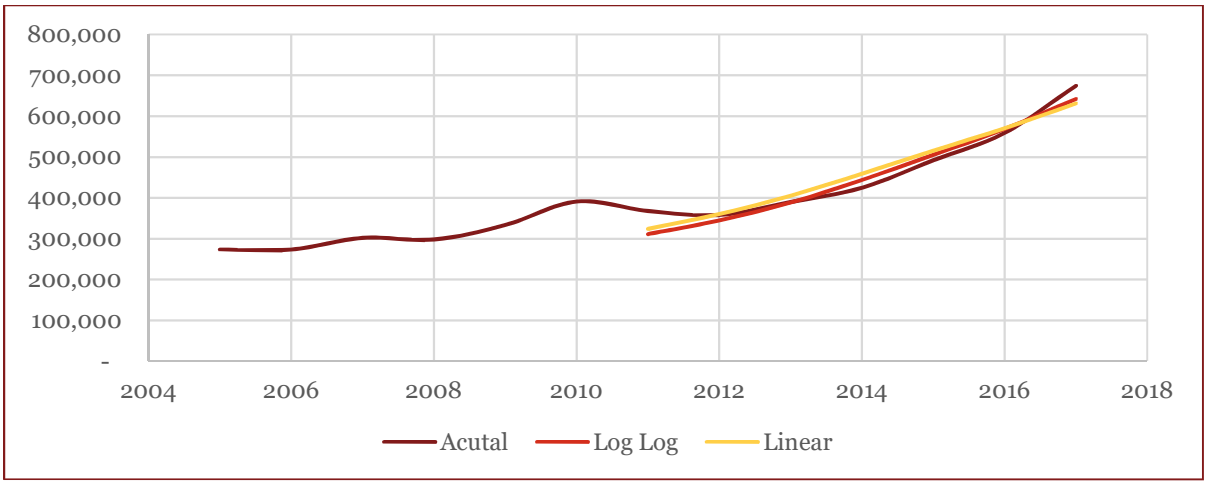
International passenger handling (in million)= -14.972 + 0.4185*World GDP

Positive coefficient for world GDP: Traffic grows as GDP grows

Strong statistical correlation: R squared value is 0.98

C.3. Regression for air cargo

Figure 94: International cargo regression curve



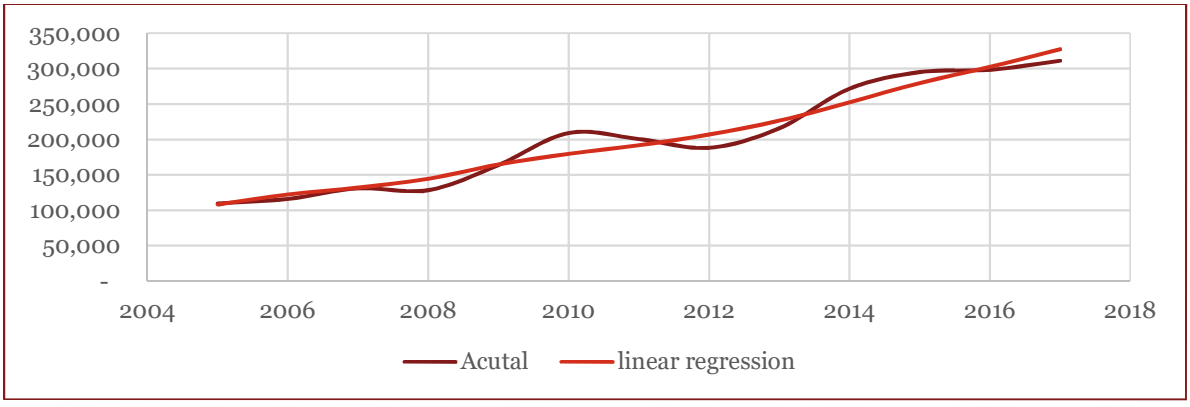
Source: PwC

Table 54: ANOVA table for International cargo regression

	df	SS	MS	F	Significance F
Regression	1	0.05	0.05	160.6	0.000223152
Residual	4	0.00	0.00		
Total	5	0.05	0.01		
R square	0.97				
Adjusted R square	**0.97**				

Source: PwC

Figure 95: Domestic cargo regression curve



Source: PwC analysis

Table 55: ANOVA table for domestic cargo regression

	df	SS	MS	F	Significance F
Regression	1	10.13	10.13	255.5	5.83082E-09
Residual	11	0.44	0.04		
Total	12	10.57	0.88		
R square	0.96				
Adjusted R square	**0.95**				

Source: PwC analysis

Appendix D. - Total demand for air travel

D.1. Total hinterland demand and demand profile

Year	Domestic passengers(in million)	International passengers (in million)	Total passengers (in million)	Split of Domestic and International Traffic (million passengers)					
				International Travel (foreigner national)		International Travel (Indians)		Domestic Travel	
				Business	Non-business	Business	Non-business	Business	Non-Business
2016 to 2017	42.2	15.5	57.7	0.84	4.81	4.04	5.81	16.31	25.90
2017 to 2018	45.7	16.6	62.4	0.90	5.17	4.32	6.22	17.68	28.07
2018 to 2019	49.5	17.7	67.3	0.97	5.52	4.61	6.63	19.14	30.40
2019 to 2020	53.9	18.9	72.8	1.03	5.88	4.90	7.05	20.85	33.10
2020 to 2021	58.9	20.0	78.9	1.09	6.24	5.19	7.47	22.75	36.12
2021 to 2022	64.3	21.1	85.5	1.16	6.60	5.49	7.90	24.87	39.48
2022 to 2023	70.1	22.3	92.4	1.22	6.97	5.79	8.33	27.09	43.01

Year	Domestic passengers(in million)	International passengers (in million)	Total passengers (in million)	Split of Domestic and International Traffic (million passengers)					
				International Travel (foreigner national)		International Travel (Indians)		Domestic Travel	
				Business	Non-business	Business	Non-business	Business	Non-Business
2023 to 2024	76.1	23.5	99.6	1.29	7.35	6.10	8.77	29.41	46.69
2024 to 2025	82.3	24.7	107.0	1.35	7.73	6.41	9.22	31.81	50.50
2025 to 2026	88.7	26.0	114.6	1.42	8.12	6.73	9.68	34.27	54.41
2026 to 2027	95.2	27.2	122.4	1.49	8.52	7.05	10.15	36.79	58.41
2027 to 2028	101.9	28.5	130.4	1.56	8.93	7.38	10.62	39.36	62.50
2028 to 2029	108.6	29.8	138.5	1.64	9.34	7.72	11.11	41.99	66.66
2029 to 2030	115.4	31.1	146.5	1.71	9.76	8.05	11.59	44.58	70.79
2030 to 2031	122.0	32.4	154.4	1.78	10.19	8.38	12.06	47.14	74.84
2031 to 2032	128.4	33.7	162.1	1.86	10.63	8.69	12.51	49.63	78.79
2032 to 2033	134.7	34.9	169.6	1.94	11.07	8.97	12.91	52.05	82.63

Year	Domestic passengers(in million)	International passengers (in million)	Total passengers (in million)	Split of Domestic and International Traffic (million passengers)					
				International Travel (foreigner national)		International Travel (Indians)		Domestic Travel	
				Business	Non-business	Business	Non-business	Business	Non-Business
2033 to 2034	140.7	36.0	176.7	2.02	11.53	9.20	13.24	54.38	86.34
2034 to 2035	146.4	37.0	183.4	2.10	11.99	9.38	13.50	56.59	89.85
2035 to 2036	151.8	37.8	189.6	2.18	12.45	9.51	13.69	58.66	93.14
2036 to 2037	156.7	38.6	195.3	2.26	12.92	9.60	13.81	60.57	96.17
2037 to 2038	161.2	39.2	200.4	2.35	13.40	9.61	13.83	62.30	98.92
2038 to 2039	165.2	39.7	204.8	2.43	13.88	9.57	13.77	63.83	101.34
2039 to 2040	168.9	40.0	208.9	2.51	14.36	9.50	13.67	65.26	103.62
2040 to 2041	172.7	40.4	213.1	2.60	14.85	9.42	13.56	66.73	105.94
2041 to 2042	176.6	40.8	217.4	2.68	15.33	9.34	13.45	68.23	108.33
2042 to 2043	180.5	41.2	221.7	2.77	15.81	9.27	13.33	69.76	110.76

Year	Domestic passengers(in million)	International passengers (in million)	Total passengers (in million)	Split of Domestic and International Traffic (million passengers)					
				International Travel (foreigner national)		International Travel (Indians)		Domestic Travel	
				Business	Non-business	Business	Non-business	Business	Non-Business
2043 to 2044	184.6	41.6	226.1	2.85	16.30	9.19	13.22	71.33	113.25
2044 to 2045	188.7	41.9	230.7	2.94	16.78	9.11	13.11	72.93	115.79
2045 to 2046	193.0	42.3	235.3	3.02	17.26	9.03	13.00	74.57	118.39
2046 to 2047	197.3	42.7	240.0	3.11	17.74	8.96	12.89	76.24	121.04
2047 to 2048	201.7	43.1	244.8	3.19	18.22	8.89	12.79	77.94	123.75
2048 to 2049	206.2	43.5	249.7	3.28	18.71	8.82	12.69	79.68	126.51

Appendix E. - Demand allotment

E.1. Allotment of districts to airport (s)

Name of district	Distance to IGIA (km)	Distance to Jewar (km)	Time to IGIA (hours)	Time to Jewar (hours)	Current airport preference
Saharanpur District, India	187.81	223.05	4.4	4.82	IGI Delhi
Muzaffarnagar District, India	147.58	177.99	3.6	3.92	IGI Delhi
Bijnor District, India	200.68	201.49	4.7	4.53	Both
Baghpat District, India	84.97	130.52	2.5	3.03	IGI Delhi
Meerut District, India	85.46	110.72	2.5	2.82	IGI Delhi
Ghaziabad District, India	56.01	86.42	1.6	1.88	IGI Delhi
Amroha District, India	151.92	152.89	3.3	3.13	Both
Bulandshahar District, India	109.92	63.25	2.6	1.75	Jewar
Rampur District, India	226.43	227.24	4.8	4.58	Both
Moradabad District, India	206.48	207.28	4.7	4.48	Both
Mathura District, India	176.71	94.15	2.9	2.00	Jewar
Haridwar District, India	225.15	255.40	5.0	5.32	IGI Delhi
Karnal District, India	157.72	219.84	3.0	3.82	IGI Delhi
Kaithal District, India	189.90	251.86	3.9	4.78	IGI Delhi
Panipat District, India	106.22	168.34	2.3	3.13	IGI Delhi

Name of district	Distance to IGIA (km)	Distance to Jewar (km)	Time to IGIA (hours)	Time to Jewar (hours)	Current airport preference
Sonipat District, India	77.57	139.69	2.0	2.88	IGI Delhi
Mewat District, India	72.10	73.22	1.7	2.32	IGI Delhi
Faridabad District, India	35.08	82.40	1.0	1.53	IGI Delhi
Bareilly District, India	287.75	288.72	5.5	5.32	IGI Delhi
Alwar District, India	153.21	151.76	3.1	4.1	IGI Delhi
North East Delhi, India	27.84	82.56	1.0	1.6	IGI Delhi
Jind District, India	145.16	208.25	3.0	4.3	IGI Delhi
Hisar District, India	175.26	263.13	3.2	4.7	IGI Delhi
Bhiwani District, India	137.92	225.79	3.0	4.5	IGI Delhi
Rohtak District, India	82.88	170.75	1.8	3.2	IGI Delhi
Jhajjar District, India	57.94	144.52	1.3	2.9	IGI Delhi
Mahindergarh District, India	119.25	165.60	2.5	3.9	IGI Delhi
Rawari District, India	94.15	140.50	1.9	3.2	IGI Delhi
Gurgaon District, India	37.82	90.12	0.9	2.3	IGI Delhi
Jhunjhunu District, India	211.63	261.68	4.6	6.0	IGI Delhi
Sikar District, India	278.09	324.44	5.3	6.6	IGI Delhi
Jaipur District, India	233.52	279.86	4.0	5.3	IGI Delhi

Name of district	Distance to IGIA (km)	Distance to Jewar (km)	Time to IGIA (hours)	Time to Jewar (hours)	Current airport preference
North West Delhi, India	27.52	103.16	1.0	2.1	IGI Delhi
South Delhi, India	12.87	88.19	0.6	1.8	IGI Delhi
West Delhi, India	23.66	104.77	0.9	2.1	IGI Delhi
South West Delhi, India	16.09	97.53	0.4	2.0	IGI Delhi
East Delhi, India	25.59	72.10	0.9	1.3	IGI Delhi
North Delhi, India	38.30	100.42	1.0	1.8	IGI Delhi
Central Delhi, India	18.51	79.98	0.7	1.5	IGI Delhi
New Delhi, India	12.23	78.21	0.4	1.4	IGI Delhi
Buduan District, India	219.51	165.92	5.2	4.0	Jewar
Hathras District, India	190.55	107.99	3.2	2.1	Jewar
Agra District, India	234.96	152.40	3.5	2.5	Jewar
Bharatpur District, India	244.62	161.90	4.6	3.5	Jewar
Firozabad District, India	267.31	184.75	4.3	3.2	Jewar
Gautam Buddh Nagar District, India	69.20	34.28	1.4	0.8	Both
Aligarh District, India	164.31	103.00	3.2	2.2	Jewar
Kanshiram Nagar District, India	222.41	161.09	4.6	3.6	Jewar

Name of district	Distance to IGIA (km)	Distance to Jewar (km)	Time to IGIA (hours)	Time to Jewar (hours)	Current airport preference
Etah District, India	236.41	175.10	4.9	4.0	Jewar

Note: The time mentioned (in hours) are in a decimal format- 4.5 hours means 4 hours and 30 minutes

Source: Google maps

Appendix F. - Origin-destination pair feasibility at Jewar Airport

F.1. International destinations

DESTINATION	2022 to 2023	2023 to 2024	2024 to 2025	2025 to 2026	2026 to 2027	2027 to 2028	2028 to 2029	2029 to 2030	2030 to 2031	2031 to 2032	2032 to 2033	2033 to 2034	2034 to 2035	2035 to 2036	2036 to 2037	2037 to 2038	2038 to 2039	2039 to 2040	2040 to 2041	2041 to 2042	2042 to 2043	2043 to 2044	2044 to 2045	2045 to 2046	2046 to 2047	2047 to 2048	2048 to 2049
DUBAI	542	610	684	782	897	1038	1209	1401	1612	1843	2079	2315	2547	2907	3263	3608	3810	3998	4188	4380	4574	4766	4958	5150	5341	5532	5723
LONDON	0	0	0	0	0	0	593	686	790	903	1019	1134	1248	1424	1599	1768	1867	1959	2053	2147	2242	2336	2430	2524	2617	2711	2805
BANGKOK	0	0	0	0	0	0	0	623	716	819	924	1029	1132	1292	1450	1604	1694	1777	1862	1947	2033	2119	2204	2289	2374	2459	2544
KATHMANDU	0	0	0	0	333	385	448	519	597	683	770	858	944	1077	1209	1337	1412	1482	1552	1623	1695	1766	1838	1909	1979	2050	2121
SINGAPORE	0	0	0	0	0	0	0	0	550	628	709	790	869	991	1113	1231	1300	1364	1429	1494	1560	1626	1691	1756	1822	1887	1952
ABUDHABI	0	0	0	0	0	338	393	456	524	600	676	753	829	946	1062	1174	1240	1301	1363	1425	1488	1551	1614	1676	1738	1800	1862
HONG KONG	0	0	0	0	0	0	0	0	0	0	584	651	716	817	917	1014	1071	1124	1177	1231	1286	1340	1394	1448	1501	1555	1609
DOHA	0	0	0	0	0	0	336	390	448	513	578	644	709	809	908	1004	1060	1112	1165	1219	1273	1326	1380	1433	1486	1539	1592
FRANKFURT	0	0	0	0	0	0	0	0	0	0	0	0	566	646	726	802	847	889	931	974	1017	1060	1103	1145	1188	1230	1273
KUALALUMPUR	0	0	0	0	0	0	0	0	356	407	460	512	563	642	721	798	842	884	926	968	1011	1054	1096	1138	1181	1223	1265
MUSCAT	0	0	0	0	0	0	0	0	335	383	432	481	529	604	678	749	791	830	870	910	950	990	1030	1069	1109	1149	1188
AMSTERDAM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	594	628	659	690	722	754	785	817	848	880	911	943
MOSCOW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	565	593	621	649	678	707	735	764	792	820	849
PARIS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	566	593	621	648	675	702	730	757	784	811
KABUL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	551	577	603	630	656	683	709	735	762	788
TORONTO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	562	587	613	639	665	690	716	742	767
DAMMAM	0	0	0	0	0	0	0	0	0	0	0	0	0	360	404	447	472	495	519	543	567	591	614	638	662	686	709
ISTANBUL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	555	578	602	625	648	671	694
BAHRAIN	0	0	0	0	0	0	0	0	0	0	0	0	0	348	390	432	456	478	501	524	547	570	593	616	639	662	685
PEKING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	549	571	593	615	637	659
JEDDAH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	548	569	590	611	632
COLOMBO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	354	392	414	434	455	476	497	518	538	559	580	601	622
SHARJAH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	353	390	412	432	453	473	494	515	536	556	577	598	618
GUANGZHOU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	548	568	588	609
KUWAIT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	545
RIYADH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	328	342	357	371	386	400	414	428
DHAKA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	327

Note: The numbers indicate daily estimated passenger handling due to the destination, green denotes the year in which destination becomes feasible

Source: PwC analysis

F.2. Domestic destinations

	2022 to 2023	2023 to 2024	2024 to 2025	2025 to 2026	2026 to 2027	2027 to 2028	2028 to 2029	2029 to 2030	2030 to 2031	2031 to 2032	2032 to 2033	2033 to 2034	2034 to 2035	2035 to 2036	2036 to 2037	2037 to 2038	2038 to 2039	2039 to 2040	2040 to 2041	2041 to 2042	2042 to 2043	2043 to 2044	2044 to 2045	2045 to 2046	2046 to 2047	2047 to 2048	2048 to 2049
BENGALURU	3019	3290	3588	4090	4707	5513	6505	7597	8736	9923	11075	12160	13145	15009	16756	18347	19747	21066	22435	23849	25309	26805	28337	29905	31511	33154	34835
MUMBAI	2090	2278	2484	2832	3259	3816	4503	5260	6048	6870	7667	8419	9100	10391	11600	12701	13671	14584	15532	16511	17522	18557	19618	20704	21815	22953	24117
PUNE	1742	1898	2070	2360	2716	3180	3753	4383	5040	5725	6389	7016	7584	8659	9667	10585	11392	12153	12943	13759	14601	15464	16348	17253	18179	19127	20097
GOA	1277	1392	1518	1730	1991	2332	2752	3214	3696	4198	4685	5145	5561	6350	7089	7762	8354	8912	9492	10090	10708	11341	11989	12652	13332	14027	14738
KOLKATA	1277	1392	1518	1730	1991	2332	2752	3214	3696	4198	4685	5145	5561	6350	7089	7762	8354	8912	9492	10090	10708	11341	11989	12652	13332	14027	14738
HYDERABAD	1161	1265	1380	1573	1810	2120	2502	2922	3360	3816	4259	4677	5056	5773	6445	7056	7595	8102	8629	9173	9734	10310	10899	11502	12120	12752	13398
CHENNAI	1045	1139	1242	1416	1629	1908	2252	2630	3024	3435	3834	4209	4550	5196	5800	6351	6835	7292	7766	8255	8761	9279	9809	10352	10908	11476	12058
AHMEDABAD	0	1012	1104	1259	1448	1696	2001	2338	2688	3053	3408	3742	4045	4618	5156	5645	6076	6482	6903	7338	7787	8248	8719	9202	9696	10201	10718
KOCHI	697	759	828	944	1086	1272	1501	1753	2016	2290	2556	2806	3033	3464	3867	4234	4557	4861	5177	5504	5841	6186	6539	6901	7272	7651	8039
INDORE	0	0	0	0	0	1060	1251	1461	1680	1908	2130	2339	2528	2886	3222	3528	3797	4051	4314	4586	4867	5155	5449	5751	6060	6376	6699
PATNA	0	0	0	0	0	1060	1251	1461	1680	1908	2130	2339	2528	2886	3222	3528	3797	4051	4314	4586	4867	5155	5449	5751	6060	6376	6699
COIMBATORE	0	0	0	629	724	848	1001	1169	1344	1527	1704	1871	2022	2309	2578	2823	3038	3241	3452	3669	3894	4124	4360	4601	4848	5101	5359
SURAT	0	0	0	0	0	0	1001	1169	1344	1527	1704	1871	2022	2309	2578	2823	3038	3241	3452	3669	3894	4124	4360	4601	4848	5101	5359
GUWAHATI	0	0	0	0	0	0	751	877	1008	1145	1278	1403	1517	1732	1933	2117	2278	2431	2589	2752	2920	3093	3270	3451	3636	3825	4019
RANCHI	0	0	0	0	0	0	0	0	1008	1145	1278	1403	1517	1732	1933	2117	2278	2431	2589	2752	2920	3093	3270	3451	3636	3825	4019
TRIVANDRUM	0	0	0	0	543	636	751	877	1008	1145	1278	1403	1517	1732	1933	2117	2278	2431	2589	2752	2920	3093	3270	3451	3636	3825	4019
VADODARA	0	0	0	0	0	0	0	0	1008	1145	1278	1403	1517	1732	1933	2117	2278	2431	2589	2752	2920	3093	3270	3451	3636	3825	4019
VARANASI	0	0	0	0	0	0	0	0	1008	1145	1278	1403	1517	1732	1933	2117	2278	2431	2589	2752	2920	3093	3270	3451	3636	3825	4019
SRINAGAR	0	0	0	0	0	0	0	0	1008	1145	1278	1403	1517	1732	1933	2117	2278	2431	2589	2752	2920	3093	3270	3451	3636	3825	4019
BHUBANESWAR	0	0	0	0	0	0	0	0	0	0	852	935	1011	1155	1289	1411	1519	1620	1726	1835	1947	2062	2180	2300	2424	2550	2680
LUCKNOW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1411	1519	1620	1726	1835	1947	2062	2180	2300	2424	2550	2680
RAIPUR	0	0	0	0	0	0	0	0	0	0	852	935	1011	1155	1289	1411	1519	1620	1726	1835	1947	2062	2180	2300	2424	2550	2680
AGARTALA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	917	973	1031	1090	1150	1212	1275	1340
AMRITSAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1275	1340
LEH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1031	1090	1150	1212	1275	1340
MADURAI	0	0	0	0	0	0	0	0	0	0	0	0	0	577	644	706	759	810	863	917	973	1031	1090	1150	1212	1275	1340
UDAIPUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1031	1090	1150	1212	1275	1340

Note: The numbers indicate daily estimated passenger handling due to the destination, green denotes the year in which destination becomes feasible

Source: PwC analysis

Appendix G. - Final demand at Jewar Airport

G.1. Breakup of demand at Jewar

Table 56: Breakup of final demand at Jewar Airport, million passengers handled annually

	International Trips- Foreigners Non-Business	International Trips- Foreigners Business	International Trips- Indians Non-Business	International Trips- Indians Business	Domestic Trips- Non-Business	Domestic Trips- Business	Domestic (total)	International (total)	RCS
2022 to 2023	0.16	0.00	0.02	0.02	2.76	1.74	4.49	0.20	0.18
2023 to 2024	0.18	0.00	0.03	0.02	3.23	2.03	5.27	0.22	0.21
2024 to 2025	0.20	0.00	0.03	0.02	3.52	2.22	5.74	0.25	0.25
2025 to 2026	0.22	0.01	0.03	0.02	4.16	2.62	6.78	0.29	0.29
2026 to 2027	0.34	0.01	0.06	0.04	4.91	3.09	8.00	0.45	0.34
2027 to 2028	0.47	0.01	0.09	0.06	6.22	3.92	10.14	0.64	0.38
2028 to 2029	0.77	0.03	0.17	0.12	7.73	4.87	12.60	1.09	0.44
2029 to 2030	1.01	0.04	0.26	0.18	9.03	5.69	14.72	1.49	0.49
2030 to 2031	1.43	0.06	0.40	0.28	11.29	7.11	18.40	2.16	0.55
2031 to 2032	1.58	0.07	0.48	0.34	12.82	8.07	20.89	2.47	0.61
2032 to 2033	1.88	0.09	0.61	0.42	14.69	9.25	23.94	3.00	0.67
2033 to 2034	2.06	0.11	0.70	0.48	16.13	10.16	26.29	3.35	0.73
2034 to 2035	2.37	0.13	0.82	0.57	17.44	10.98	28.42	3.89	0.80
2035 to 2036	2.78	0.16	1.03	0.72	20.04	12.62	32.66	4.70	0.87
2036 to 2037	3.21	0.20	1.25	0.87	22.37	14.09	36.46	5.53	0.93
2037 to 2038	3.64	0.24	1.44	1.00	24.81	15.63	40.44	6.33	1.00
2038 to 2039	3.95	0.28	1.57	1.09	26.70	16.82	43.52	6.89	1.06
2039 to 2040	4.38	0.32	1.73	1.21	28.49	17.94	46.43	7.64	1.13
2040 to 2041	4.71	0.36	1.85	1.29	30.34	19.11	49.45	8.21	1.19
2041 to 2042	5.00	0.39	1.95	1.36	32.46	20.44	52.90	8.70	1.26
2042 to 2043	5.35	0.43	2.07	1.44	34.44	21.69	56.14	9.29	1.33

	International Trips- Foreigners Non-Business	International Trips- Foreigners Business	International Trips- Indians Non-Business	International Trips- Indians Business	Domestic Trips- Non-Business	Domestic Trips- Business	Domestic (total)	International (total)	RCS
2043 to 2044	5.70	0.47	2.19	1.52	36.94	23.27	60.21	9.88	1.41
2044 to 2045	6.07	0.52	2.30	1.60	39.05	24.60	63.65	10.48	1.49
2045 to 2046	6.44	0.56	2.41	1.68	41.21	25.96	67.17	11.08	1.57
2046 to 2047	6.70	0.60	2.48	1.72	43.43	27.35	70.78	11.50	1.65
2047 to 2048	6.96	0.63	2.54	1.77	45.98	28.96	74.93	11.91	1.73
2048 to 2049	7.42	0.69	2.67	1.86	48.31	30.43	78.73	12.64	1.82

Note: Domestic (total) does not include RCS traffic

Source: PwC analysis

Appendix H. - Upcoming investments in electronics in Gautam Buddh Nagar

Company Name	Project Name	Cost (million INR)	Project Status	Location	District	State
Samsung India Electronics Pvt. Ltd.	Noida Mobile Phone & White Goods Manufacturing Plant Capacity Expansion Project	49,150.00	Announced	Noida	Gautam Buddha Nagar	UP
Intex Technologies (india) Ltd.	Greater Noida (Kasna Rd.) Smart-Phones & Consumer Durable Plant Project	15,000.00	Under Implementation	Greater Noida	Gautam Buddha Nagar	UP
L G Electronics India Pvt. Ltd.	Greater Noida Electronic Appliances and Mobile Phone Mfg. Plant Project	13,280.00	Announced	Greater Noida	Gautam Buddha Nagar	UP
Lava International Ltd.	Noida (Yamuna expressway) Handset (bigger) Plant Project	6,000.00	Under Implementation	Yamuna expressway	Uttar Pradesh Districts	UP
Lava International Ltd.	Noida (Yamuna expressway) Handset (bigger) Plant Project	6,000.00	Under Implementation	Noida	Gautam Buddha Nagar	UP
Lava International Ltd.	Noida (Yamuna expressway) Handset (bigger) Plant Project	6,000.00	Under Implementation	Uttar pradesh	Uttar Pradesh	UP
Welspun Corp Ltd.	Greater Noida Inverters and Cables Mfg. Plant Project	6,000.00	No Information, but Live	Greater noida	Gautam Buddha Nagar	UP
Intex Technologies (india) Ltd.	Greater Noida Consumer Durable Plant (Forth Plant) Project	5,000.00	Announced	Greater Noida	Gautam Buddha Nagar	UP
Spice Mobility Ltd.	UP Mobile Phone Manufacturing Plant Project	5,000.00	Announced	Noida	Gautam Buddha Nagar	UP

Company Name	Project Name	Cost (million INR)	Project Status	Location	District	State
Spice Mobility Ltd.	UP Mobile Phone Manufacturing Plant Project	5,000.00	Announced	Uttar pradesh	Uttar Pradesh	UP
U P Electronics Corpn. Ltd.	Yamuna Expressway (Plot No, 6/A, G Noida) Electronic Manufacturing Cluster Project	1,556.70	Under Implementation	Plot no. 6/a, yamuna expressway	Gautam Buddha Nagar	UP
Karbonn Mobile India Pvt. Ltd.	Noida Mobile phone Assembly Plant (Phase 2) Project	1,500.00	No Information, but Live	Noida	Gautam Buddha Nagar	UP
Karbonn Mobile India Pvt. Ltd.	Noida New Smart TV Manufacturing Unit Project	1,500.00	Announced	Noida	Gautam Buddha Nagar	UP
Topwise Communication Co. Ltd.	Greenfield Smartphones (Comio) Manufacturing and Assembling Unit Project	1,500.00	Announced	Noida	Gautam Buddha Nagar	UP
Patanjali Ayurved Ltd.	Greater Noida Solar Equipment Manufacturing Plant Project	1,000.00	Under Implementation	Greater noida	Gautam Buddha Nagar	UP
Shenzhen Zopo Communication Equipment Co. Ltd.	Noida Mobile Phone (Zopo Mobile) Manufacturing Plant Project	1,000.00	Announced	Noida	Gautam Buddha Nagar	UP
Sun Airvoice Pvt. Ltd.	Noida (Ziox Mobiles) Handsets Manufacturing Plant Project	1,000.00	Announced	Noida	Gautam Buddha Nagar	UP
Uttar Pradesh Development Systems Corpn. Ltd.	Greater Noida Electronic Manufacturing Cluster (EMC) Project	714.2	Announced	Greater noida	Gautam Buddha Nagar	UP
Leeco (le Holdings Co. Ltd)	Greater Noida Smartphone Assembly Plant Project (Partner-Compal Electronics)	500	Under Implementation	Greater noida	Gautam Buddha Nagar	UP
Vivo Mobile India Pvt. Ltd.	Greater Noida Mobile Phones Assembly Plant Capacity Expansion Project		Announced	Greater noida	Gautam Buddha Nagar	UP

Appendix I. - Financial assessment

I.1. Detailed list of assumptions – Financial Assessment

Following sections presents detailed list of the assumptions used in the financial assessment of this project:

I.1.1. Depreciation

Following table presents the regulatory asset life assumed for various asset classes:

Asset class	Age	Units
Buildings / Civil Infra asset life - AERA	30	years
RW / TW asset life - AERA	30	years
Utilities asset life - AERA	15	years
Equipment asset life - AERA	5	years
Lighting system asset life - AERA	10	years
Safety & Security asset life - AERA	6	years
IT equipment asset life - AERA	6	years
Software asset life - AERA	5	years
Furniture & Fixture asset life - AERA	10	years
Plant & Machinery asset life - AERA	15	years

I.1.2. Distribution between aeronautical and non-aeronautical assets, revenues and costs

I.1.2.1. Assets

Capital costs - RAB Composition	Percentage of RAB
Civil work cost	-
Property Boundary Wall	100.00%
Operational Security Wall	100.00%
Air Side Drainage	100.00%
Air Side Water Harvesting	100.00%
City Side Drains	100.00%
	-
E&M Work	-
Electrical Receiving Station	100.00%
Approach Roads Lighting	100.00%
Perimeter Lighting	100.00%
Perimeter Security	100.00%
AGL works	100.00%
Power Sub Stations	100.00%
IE of all Buildings and HVAC	100.00%
Remote Monitoring and Control of All the Facilities (BMS)	100.00%
	-
Airside Civil Work	-
Runway, Taxiway, Aprons, Isolation Bay	100.00%
Air Side Drainage	100.00%
Air Side Grading incl RESA	100.00%
Service Roads utilities and facilities	100.00%
	-
Buildings	-
Passenger Terminal Building	90.00%
Cargo Terminal Building	100.00%
Maintenance Building	90.00%
Control Tower + ATM + MET	100.00%
Management Building	85.00%
Security Staff Building	90.00%
Energy Buildings	95.00%
Fire Fighting Buildings	95.00%
Other Buildings (LLZ GP DVOR, ASR/MSSR/ Car Parking etc)	95.00%
Interconnectivity (APM Terminals)	90.00%
	-
Airport Roads & Parking	-
Airport approach Road costs	100.00%
Perimeter Security Road	100.00%
	-
Equipment	-
Fire and Safety Services	90.00%
Operational Vehicles	95.00%
Security Equipment	100.00%
Cargo Equipment	100.00%
Flight Information System	100.00%

Capital costs - RAB Composition	*Percentage of RAB*
AOCC	*100.00%*
Misc (Birds Control System, Visual Aids, Medical etc.)	*100.00%*
Terminal and Office Equipments and Veh.	*95.00%*
Pax Equipment	*95.00%*
	-
On Site Utilities	-
Communication Facility	*90.00%*
Water Supply Facilities	*90.00%*
Waste Disposal Facility	*90.00%*
Fuel Facility #	*100.00%*
	-
Misc cost	-
Other contingencies	*80.00%*
Landscaping	*80.00%*

Source: Tariff filings by different airports to AERA

I.1.2.2. Operating costs

Following table shows the breakup of cost between aeronautical and non-aeronautical. This is based on breakup observed under different airports as per their tariff filing to AERA:

Operating costs - Aero Composition	Percentage of Aero
Personnel cost	87.00%
Total utilities cost	96.00%
Insurance policy premium	85.00%
Repairs Operations & Maintenance cost per unit area	90.00%
Spares and consumables	96.00%
General Administration cost	87.00%
Marketing & Advertising cost	96.00%
Infrastructure tax	90.00%
Lease rental cost	100.00%

Source: Tariff filings by different airports to AERA

I.1.2.3. Operating Revenues

Components of revenue	Percentage of Aeronautical revenue
Landing / Housing / Parking Charges	100.00%
Aerobridge & CUTE charges	100.00%
Fuel Throughput Charges	100.00%
User Development Fee	100.00%

Components of revenue	Percentage of Aeronautical revenue
Cargo handling charges	100.00%
Ground handling charges	100.00%
Duty Free revenue	-
Foreign exchange revenue	-
Bank / ATM revenue	-
Advertisement revenue	-
Miscellaneous revenue	-
Flight kitchen revenue	-
Retail revenue	-
Food & Beverage revenue	-
Lounge revenue	-
Car park and Public admission fee revenue	-
Car rental & reservations revenue	-
Hangar rent	-
Land rent	-
Office space rent	-

Source: AERA guidelines

I.1.3. Aeronautical Revenue

Following table shows the assumptions pertaining to various categories of aeronautical revenues. These benchmarks have been arrived based on the similar figures seen at other competing airports in India.

Landing	-	
Aircraft seat capacity up to which exempted	80	#
	-	
PAX - Domestic (tariffs considered as 80% of existing tariffs at DIAL)	-	
Fixed fee for aircraft with < 80 seats	-	Rs / aircraft
Landing charges - Domestic PAX - Upto 100 MT	137	Rs / MT
Fixed Landing charges - Domestic PAX more than 100 MT	13,664	Rs / MT
Landing charges - Domestic PAX more than 100 MT	184	Rs / MT
	-	
PAX - International	-	
	-	
Landing charges - International PAX - Upto 100 MT	182	Rs / MT
Fixed Landing charges - International PAX beyond 100 MT	18,216	Rs
Landing charges - International PAX - beyond 100 MT	245	Rs / MT
Landing charges - International PAX - Spare	-	Rs / MT
Landing charges - International PAX - Spare	-	Rs / MT
	-	
Cargo - Domestic	-	
Aircraft Weight - Cargo - Limit 1	100	MT
	-	
Landing charges - Domestic Cargo < 100 MT	331	Rs / MT
Landing charges - Domestic Cargo > 100 MT	445	Rs / MT
	-	
Cargo - International	-	
Landing charges - International Cargo < 100 MT	650	Rs / MT
Landing charges - International Cargo > 100 MT	874	Rs / MT
	-	

Parking (80% of existing charges at DIAL)	-	
Aircraft Weight - Parking charges - Limit 1	100	MT
	-	
Parking charges - Domestic Aircraft < 100 MT	6	Rs / MT / hour
Parking charges - Domestic Aircraft > 100 MT	8	Rs / MT / hour
	-	
Parking charges - International Aircraft < 100 MT	6	Rs / MT / hour
Parking charges - International Aircraft > 100 MT	8	Rs / MT / hour
	-	
Housing (80% of existing charges at DIAL)	-	
Aircraft Weight - Housing charges - Limit 1	40	MT
Aircraft Weight - Housing charges - Limit 2	100	MT
	-	
Housing charges - All aircraft < 40 MT	6	Rs / MT
Housing charges - All aircraft - 40 MT to 100 MT	6	Rs / MT
Housing charges - All aircraft PAX > 100 MT	8	Rs / MT
	-	
Aerobridge & CUTE Charges (80% of existing charges at DIAL)	-	
Aerobridge & CUTE charges per ATM	520	Rs per ATM
	-	
Fuel Throughput Charges	-	
Fuel Throughput Charges - Case selection switch	1	0= Case1, 1= Case 2
Fuel Throughput Charges - Case 1	551	Rs / KL
	-	
Average fuel requirement per ATM	5.3	KL / ATM #
Cargo handling charges (benchmarked as per charges at DIAL)	-	
Cargo handling charges	1,500	Rs / MT
	-	
Ground handling charges (benchmarked to PPP airports)	-	
Ground handling charges	23	Rs / PAX

Source: Tariff filings by different airports to AERA

I.1.4. Economic IRR

Economic IRR	Units	2022	2029	2034	2039	2048
		2023	2030	2035	2040	2049
Workings						
Cash inflows						
Economic Output for investment undertaken in the airport	INR crore	0	4616	8758	14764	21014
Taxable income generated to the Government	INR crore	-	46.16	87.58	147.64	210.14
Revenue share from the Airport	INR crore	-	272.15	568.52	1,036.44	1,673.13
Taxable income from the airport	INR crore	-	192.48	236.55	448.06	1,426.57
Lease income from airport	INR crore	-	-	307.47	374.08	532.43
Total inflows	INR crore	0	5127	9958	16770	24856
Cash outflows						
RRTS Funding						
RRTS capital investments flag		1.00	-	-	-	-
RRTS capital investments cummulative flag		1.00	-	-	-	-
RRTS capital investments phasing profile		6%	0%	0%	0%	0%
RRTS Capital investment nominal cost		1,021.99	-	-	-	-
Means of financing						
Initial Equity from government	INR crore	408.80	-	-	-	-
Initial Debt for the project	INR crore	245.28	-	-	-	-

Economic IRR	Units	2022	2029	2034	2039	2048
		2023	2030	2035	2040	2049
Interest during construction	INR crore	-	-	-	-	-
Total Project cost post IDC capitalisation	INR crore	1,021.99	-	-	-	-
Equity from the govt. post IDC capitalisation	INR crore	408.80	-	-	-	-
Final Debt post IDC capitalisation	INR crore	613.19	-	-	-	-
Cumulative debt drawn		613.19	11,404.36	11,404.36	11,404.36	11,404.36
Debt repayment						
Opening Balance	INR crore	-	11,404.36	9,123.49	6,272.40	1,140.44
Addition	INR crore	613.19	-	-	-	-
RRTS Repayment profile		0%	0%	5%	5%	5%
Repayment	INR crore	-	-	570.22	570.22	570.22
Closing Balance	INR crore	613.19	11,404.36	8,553.27	5,702.18	570.22
Interest during operations	INR crore	-	855.33	662.88	449.05	64.15
Total outflow from govt. for RRTS	INR crore	408.80	855.33	1,233.10	1,019.26	1,225.97
MRTS Funding						
MRTS capital investments flag		1.00	-	-	-	-
MRTS capital investments cumulative flag		4.00	-	-	-	-
MRTS capital investments phasing profile		27%	0%	0%	0%	0%

Economic IRR	Units	2022	2029	2034	2039	2048
		2023	2030	2035	2040	2049
MRTS Capital investment nominal cost		1,149.74	-	-	-	-
Means of financing						
Initial Equity from government	INR crore	459.89	-	-	-	-
Initial Debt for the project	INR crore	275.94	-	-	-	-
Interest during construction	INR crore	-	-	-	-	-
Total Project cost post IDC capitalisation	INR crore	1,149.74	-	-	-	-
Equity from the govt. post IDC capitalisation	INR crore	459.89	-	-	-	-
Final Debt post IDC capitalisation	INR crore	689.84	-	-	-	-
Cumulative debt drawn		1,673.69	2,534.61	2,534.61	2,534.61	2,534.61
Debt repayment						
Opening Balance	INR crore	983.84	2,534.61	2,534.61	2,534.61	2,534.61
Addition	INR crore	689.84	-	-	-	-
MRTS Repayment profile		0%	0%	0%	0%	0%
Repayment	INR crore	-	-	-	-	-
Closing Balance	INR crore	1,673.69	2,534.61	2,534.61	2,534.61	2,534.61
Interest during operations	INR crore	-	190.10	190.10	190.10	190.10
Total outflow from govt. for MRTS	INR crore	459.89	190.10	190.10	190.10	11,356.89

Economic IRR	Units	2022	2029	2034	2039	2048
		2023	2030	2035	2040	2049
Cost of Road construction						
75 m road parallel to airport boundary length 4.84 km	INR crore	-	-	-	-	-
130 m road connecting Noida to Greater Noida length 25 km	INR crore	-	-	-	-	-
60 m wide road parallel to Yamuna Expressway length 30 km	INR crore	-	-	-	-	-
Road construction profile	%					
Land acquisition cost	INR crore					
Total cash outflow	INR crore	868.69	1,045.42	1,423.19	1,209.36	12,582.86
Economic IRR	23%	(868.69)	4,081.20	8,534.96	15,560.94	12,273.30

Appendix J. - Survey conducted at IGIA

A detailed survey was conducted at all the three terminals of IGIA in order to arrive at a robust understanding of the distribution of air travel demand generation across the hinterland. A sample size of over 6,000 respondents was analyzed.

Table 57: Overview of the survey sample

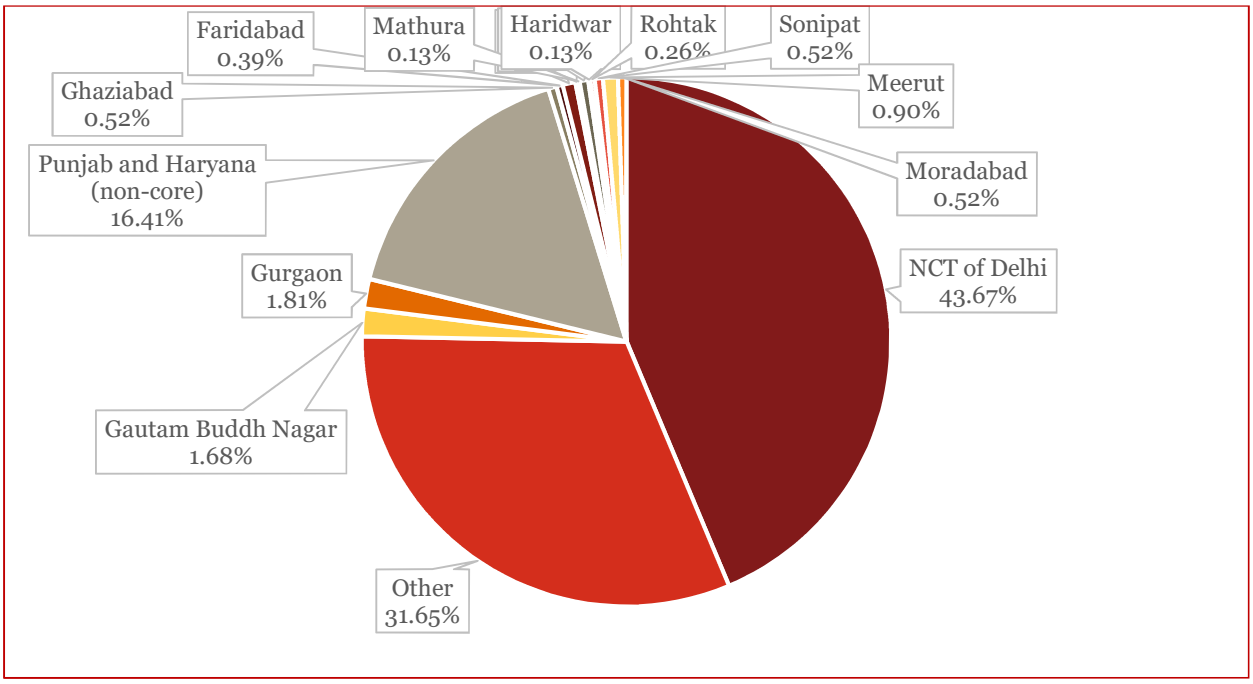
Passenger type	Number of passengers
Domestic	5565
International	774
Arrival/Departure	
Arrival	3470
Departure	2869

Out of the total sample, approximately 60 percent reported non-business related purpose of travel and rest business as their purpose of travel.

With regard to OD pattern following were the broad observations:

1. International movement
    a. NCT of Delhi, and its satellite cities of Ghaziabad, Noida (Gautam Budh Nagar), Faridabad, and Gurgaon together account for ~ 48 percent of the traffic. The state of Punjab, the parts of Haryana (beyond 150 km), and the UT of Chandigarh accounted for a share of 16 percent.
    b. About 25% of total international movement is to the Middle East (including Dubai, Abu Dhabi, Riyadh and Muscat) and rest of the movements are spread across other countries such as Paris, Toronto, London, etc.
    c. Around 30% of passengers attributable to the districts of UP are also moving to the countries in the Middle East.

Figure 96: Demand distribution across the hinterland (international traffic)

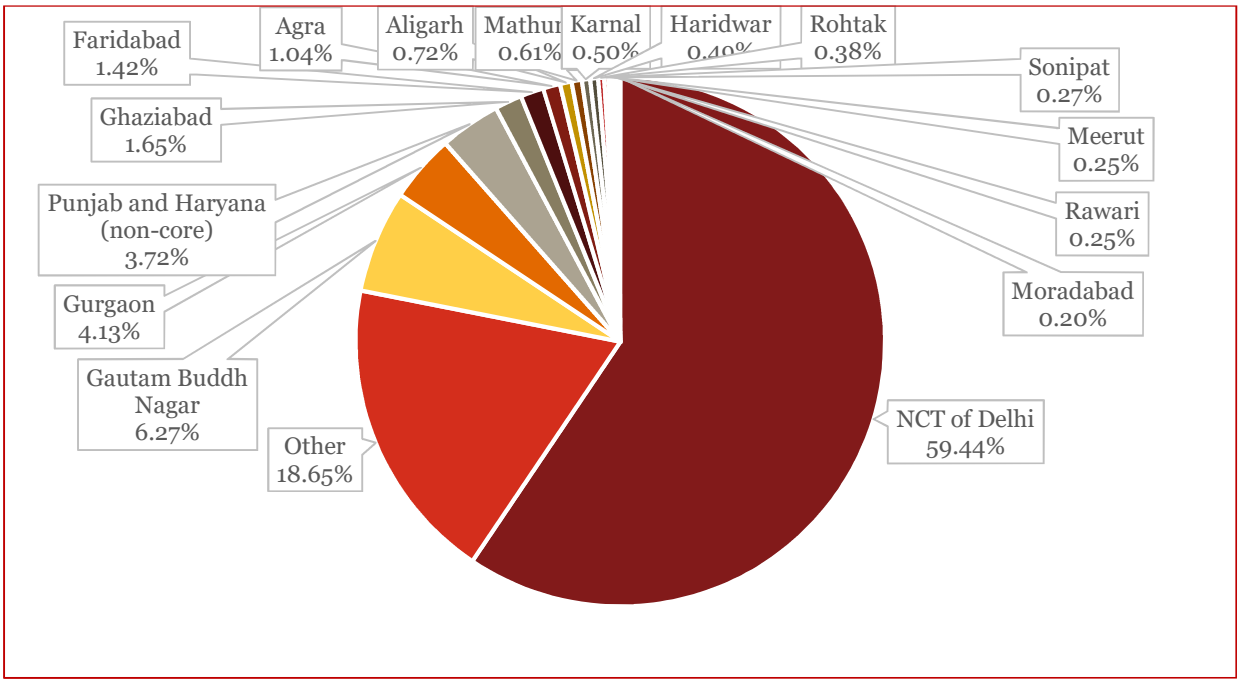


Note: Punjab and Haryana (non-core) also includes the Union Territory of Chandigarh

2. Domestic movement

- NCT of Delhi, and its satellite cities of Ghaziabad, Noida (Gautam Budh Nagar), Faridabad, and Gurgaon together account for nearly 73 percent of the domestic traffic demand generation.
- The district of Gautam Budh Nagar account for more than 6 percent of the domestic traffic generation.
- Agra, Aligarh, Ghaziabad, and Mathura together generate ~4 percent of the hinterland's domestic traffic.

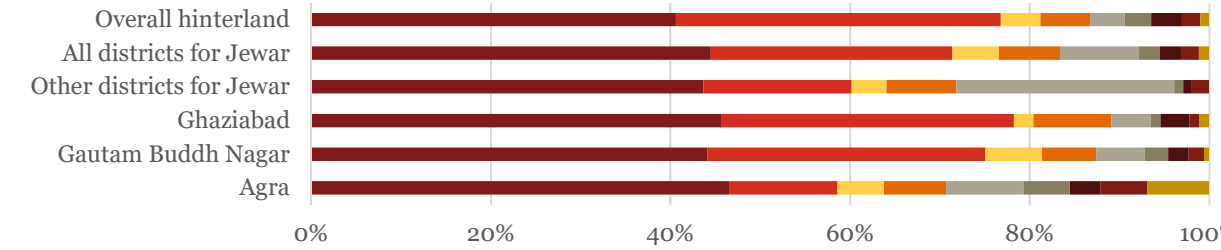
Figure 97: Demand distribution across the hinterland (domestic traffic)



Note: Punjab and Haryana (non-core) also includes the Union Territory of Chandigarh

- Overall, ~ 35 percent of the departure and arrival for Delhi are from metropolitan cities. The rest of the demand is distributed to other regions such as Ahmedabad, Goa, and Pune.
- The pattern is however different for districts in UP where the metropolitan cities account for 42 percent of the overall movement.

Figure 98: Split of hinterland demand, by hinterland region and origin/destination city

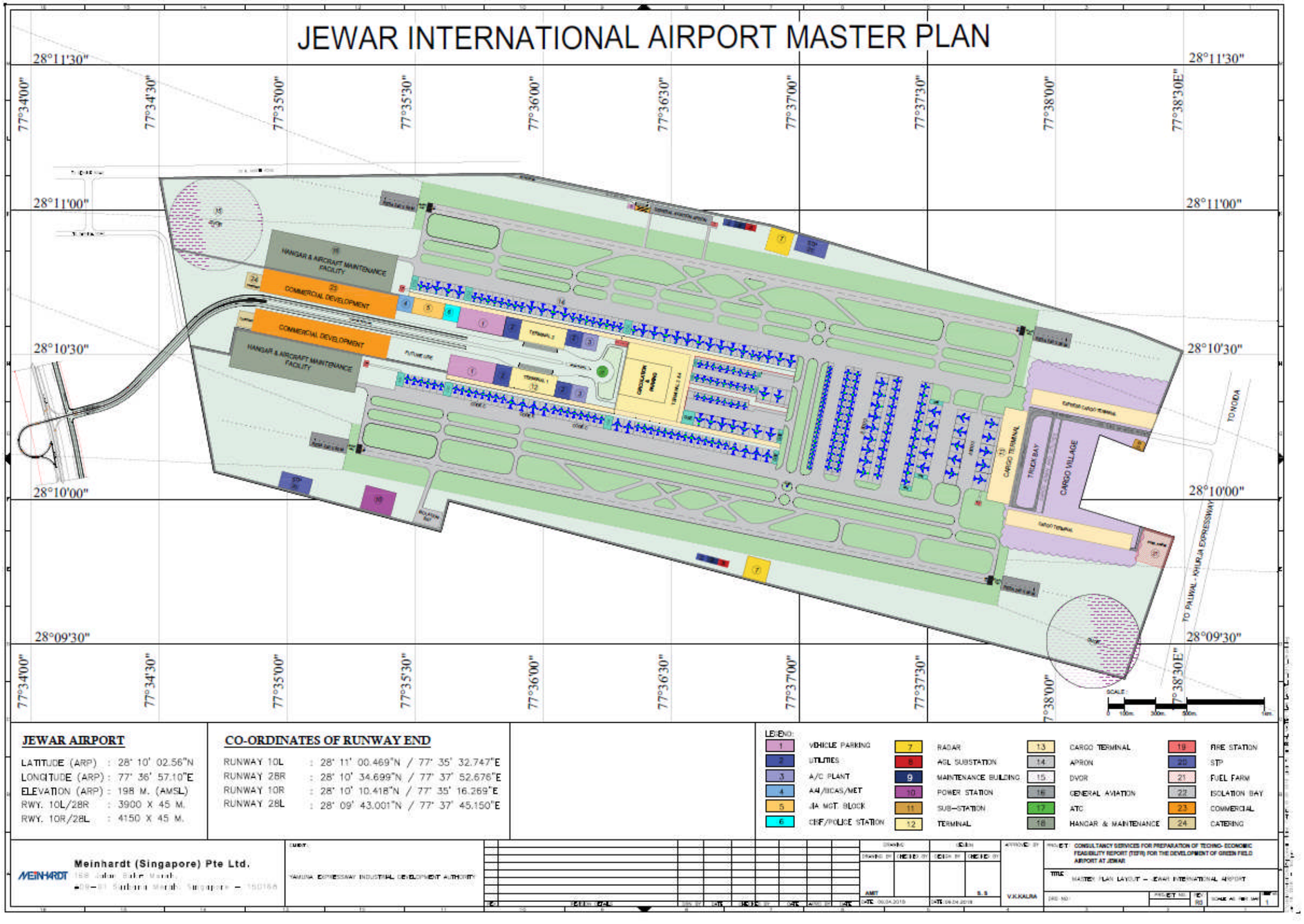


	Agra	Gautam Buddh Nagar	Ghaziabad	Other districts for Jewar	All districts for Jewar	Overall hinterland
METROPOLITAN CITIES	46.55%	44.13%	45.65%	43.69%	44.52%	40.61%
OTHER	12.07%	30.95%	32.61%	16.50%	26.91%	36.20%
AHMEDABAD	5.17%	6.30%	2.17%	3.88%	5.15%	4.42%
PUNE	6.90%	6.02%	8.70%	7.77%	6.81%	5.51%
GOA	8.62%	5.44%	4.35%	24.27%	8.80%	3.83%
SRINAGAR	5.17%	2.58%	1.09%	0.97%	2.33%	2.97%
PATNA	3.45%	2.29%	3.26%	0.97%	2.33%	3.44%
KOCHI	5.17%	1.72%	1.09%	1.94%	1.99%	2.01%
TRIVANDRUM	6.90%	0.57%	1.09%	0.00%	1.16%	1.01%

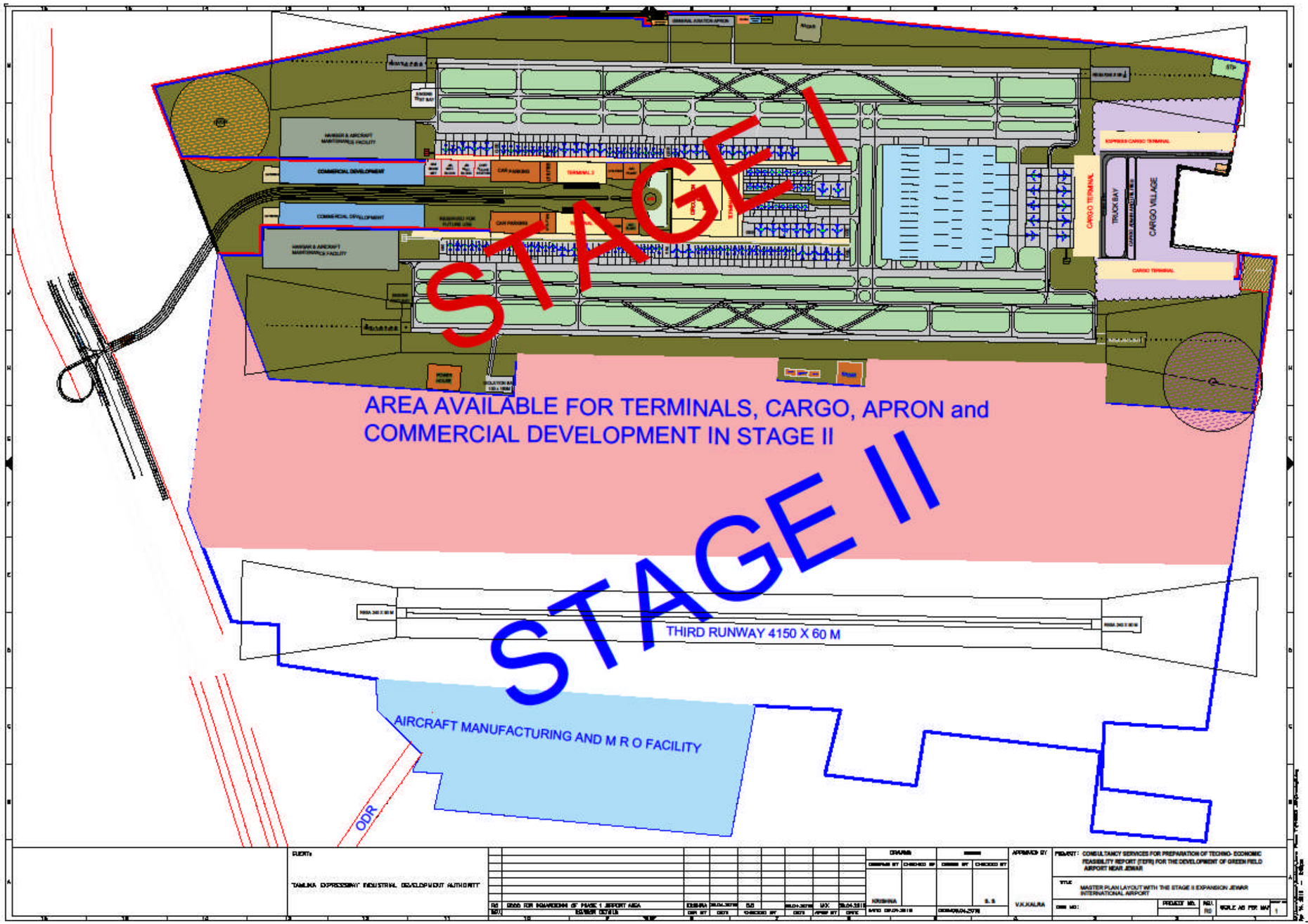
Other findings:

- 18 percent of all international travelers surveyed (which translates into ~55 percent of international tourists coming/ going via IGIA) either visited the Taj Mahal (survey passengers departing from IGIA) or intended to visit the Taj Mahal (survey passengers arriving at IGIA).

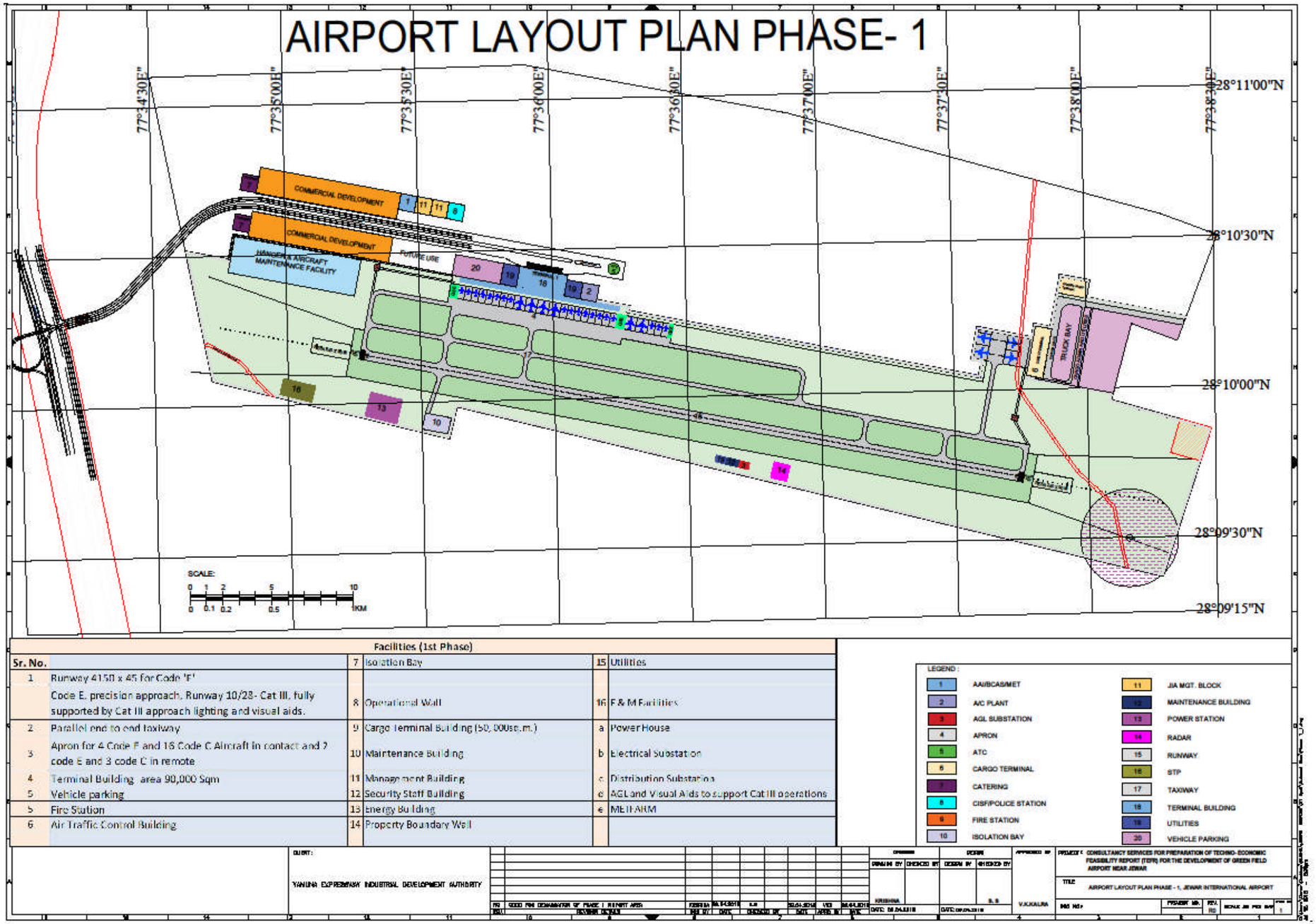
Appendix K. - Final masterplan



Appendix L. - Masterplan layout with extension



Appendix M. - Phase I layout



Facilities (1st Phase)					
Sr. No.		7	Isolation Bay	15	Utilities
1	Runway 4150 x 45 for Code 'E' Code E, precision approach, Runway 10/28- Cat III, fully supported by Cat III approach lighting and visual aids.	8	Operational Wall	16	F & M Facilities
2	Parallel end to end taxiway	9	Cargo Terminal Building (50, 000sq.m.)	a	Power House
3	Apron for 4 Code F and 16 Code C Aircraft in contact and 7 code E and 3 code C in remote	10	Maintenance Building	b	Electrical Substation
4	Terminal Building area 90,000 Sqm	11	Management Building	c	Distribution Substation
5	Vehicle parking	12	Security Staff Building	d	AGL and Visual Aids to support Cat III operations
5	Fire Station	13	Energy Building	e	METAR/M
6	Air Traffic Control Building	14	Property Boundary Wall		

LEGEND :

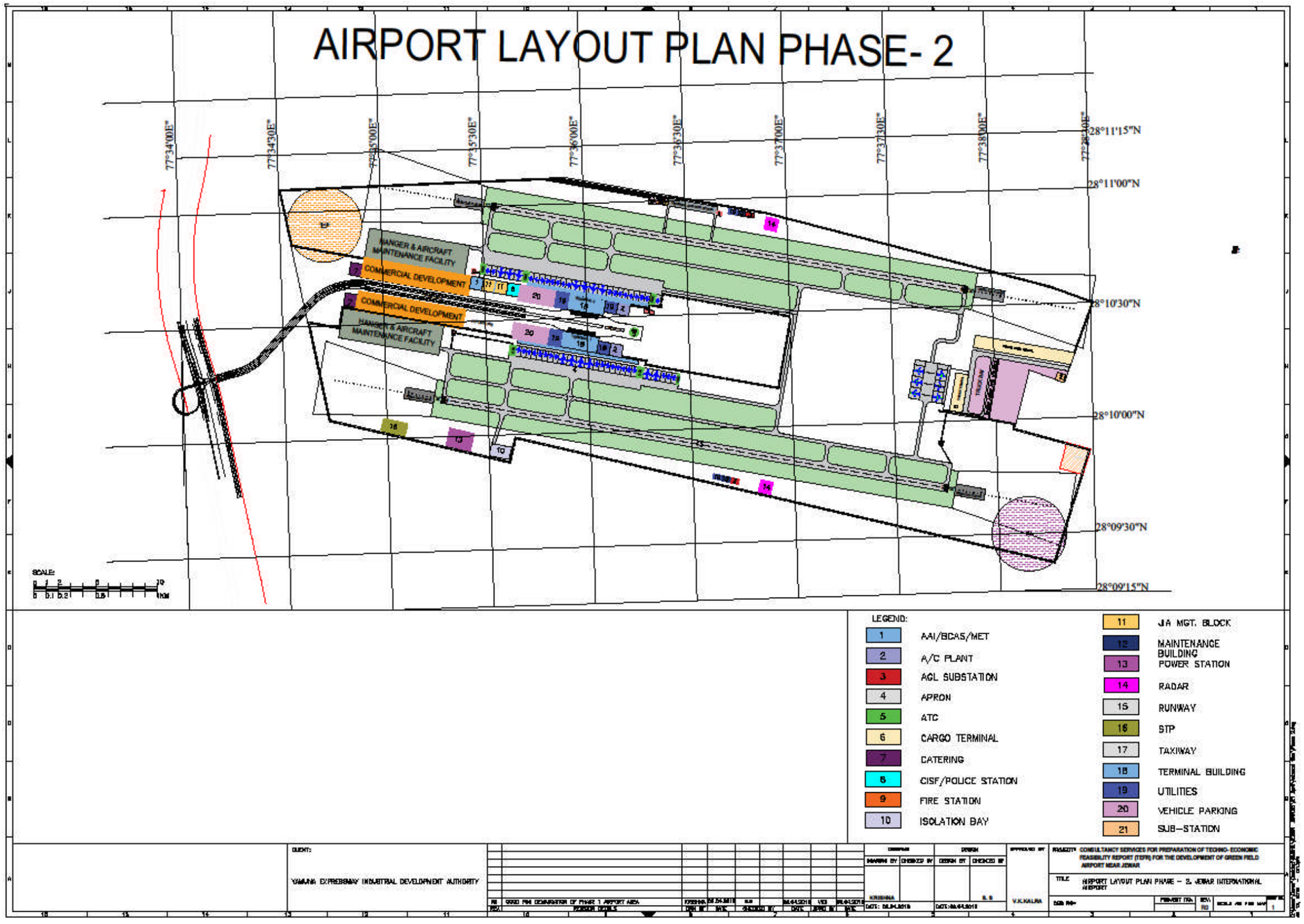
1	AAI/BCAS/MET	11	JIA MGT. BLOCK
2	A/C PLANT	12	MAINTENANCE BUILDING
3	AGL SUBSTATION	13	POWER STATION
4	APRON	14	RADAR
5	ATC	15	RUNWAY
6	CARGO TERMINAL	16	STP
7	CATERING	17	TAXIWAY
8	CISF/POLICE STATION	18	TERMINAL BUILDING
9	FIRE STATION	19	UTILITIES
10	ISOLATION BAY	20	VEHICLE PARKING

CLIENT: YAMUNA EXPRESSWAY INDUSTRIAL DEVELOPMENT AUTHORITY

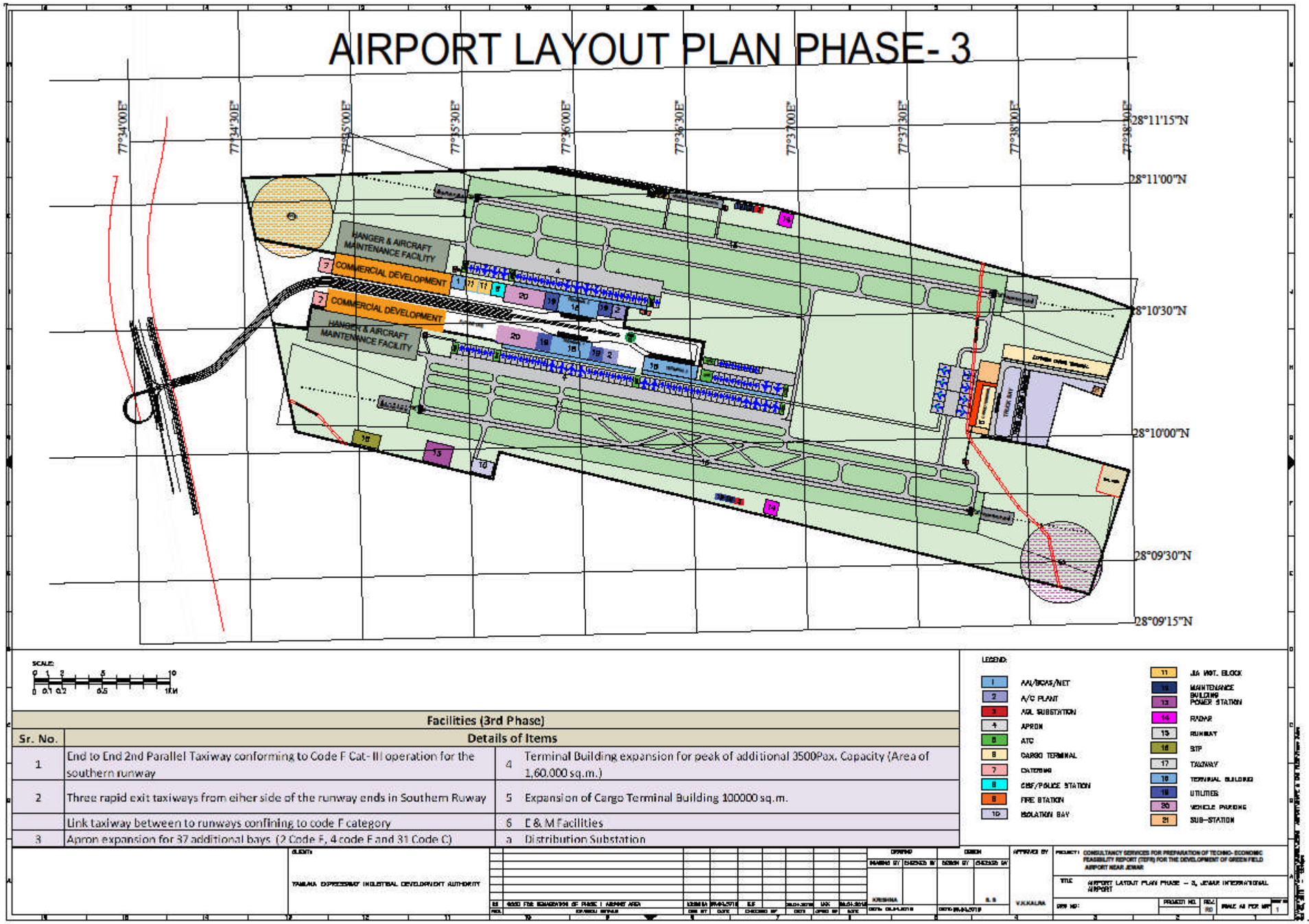
PROJECT : CONSULTANCY SERVICES FOR PREPARATION OF TECHNO- ECONOMIC FEASIBILITY REPORT (TEFR) FOR THE DEVELOPMENT OF GREEN FIELD AIRPORT NEAR JEWAR

TITLE : AIRPORT LAYOUT PLAN PHASE - 1, JEWAR INTERNATIONAL AIRPORT

Appendix N. - Phase II layout

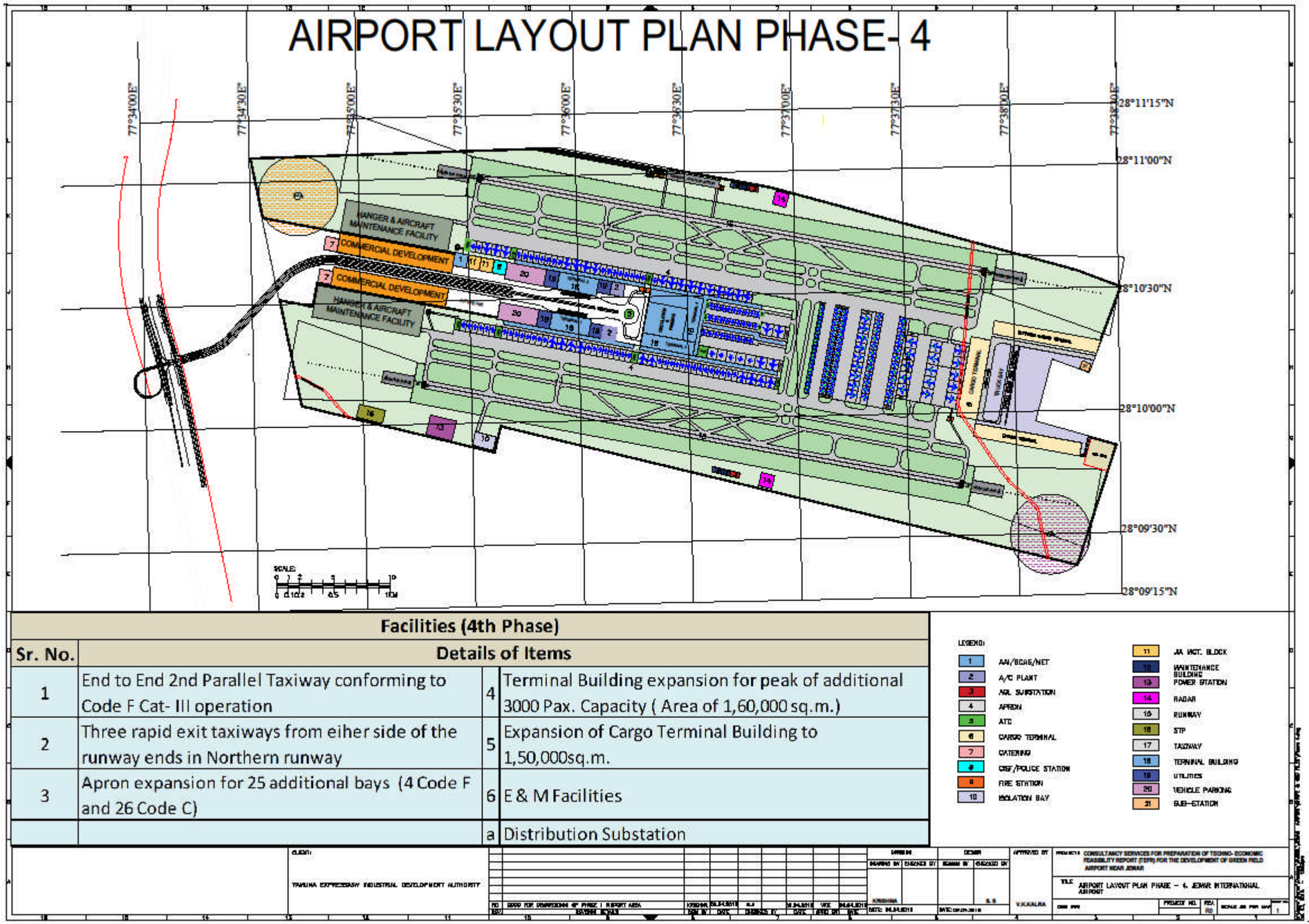


Appendix O. - Phase III layout



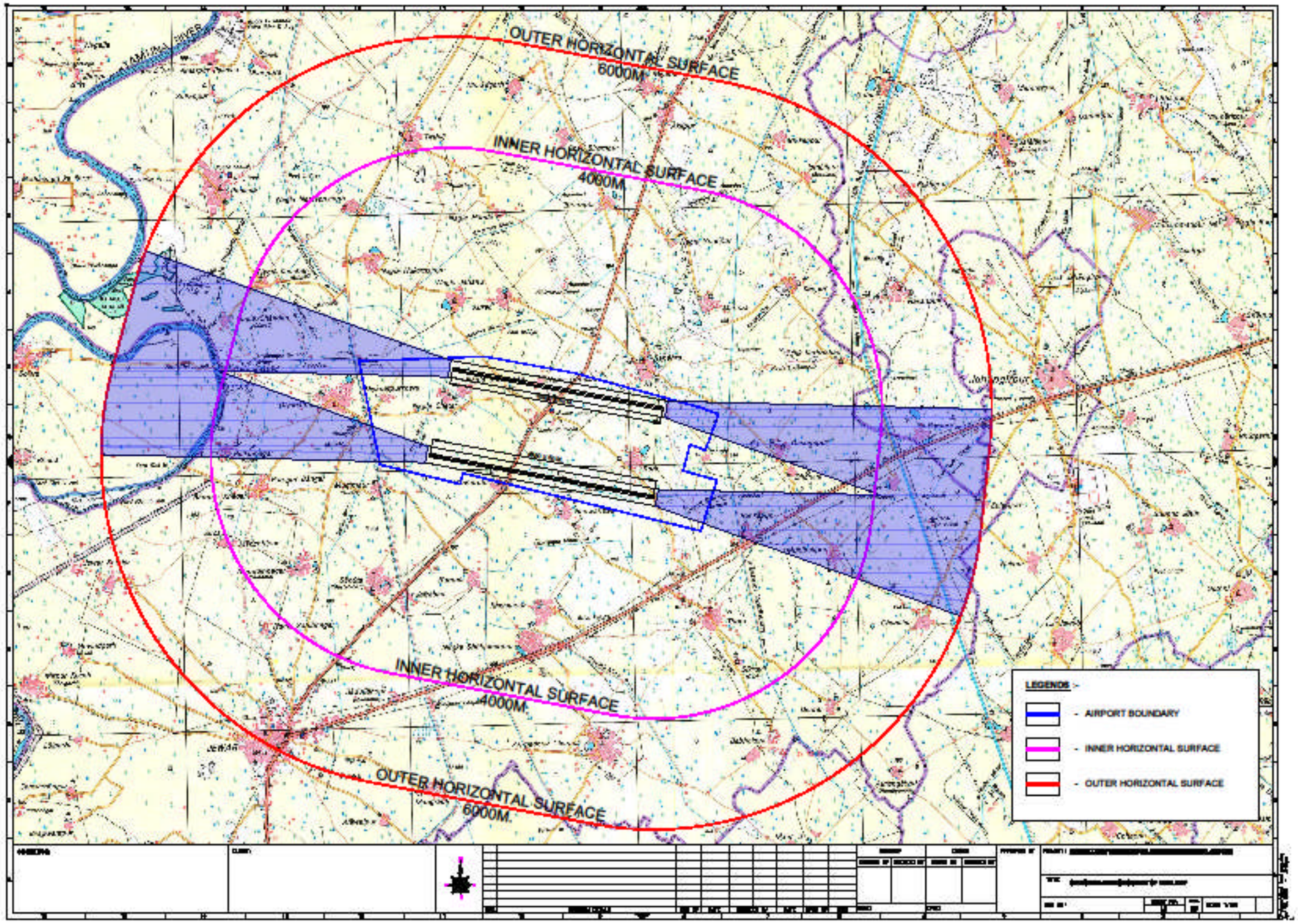
Facilities (3rd Phase)			
Sr. No.	Details of Items		
1	End to End 2nd Parallel Taxiway conforming to Code F Cat- III operation for the southern runway	4	Terminal Building expansion for peak of additional 3500Pax. Capacity (Area of 1,60,000 sq.m.)
2	Three rapid exit taxiways from either side of the runway ends in Southern Ruway	5	Expansion of Cargo Terminal Building 100000 sq.m.
	Link taxiway between to runways confining to code F category	6	E & M facilities
3	Apron expansion for 37 additional bays (2 Code F, 4 code E and 31 Code C)	a	Distribution Substation

Appendix P. - Phase IV layout

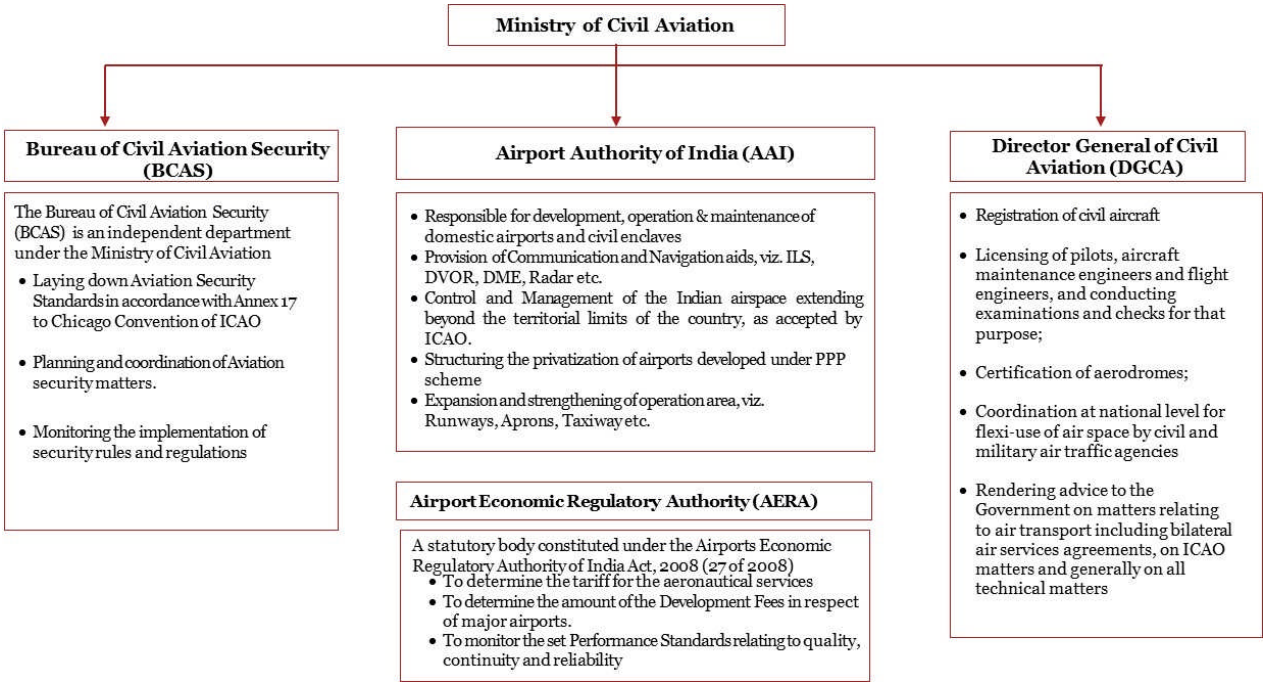


Facilities (4th Phase)			
Sr. No.	Details of Items		
1	End to End 2nd Parallel Taxiway conforming to Code F Cat- III operation	4	Terminal Building expansion for peak of additional 3000 Pax. Capacity (Area of 1,60,000 sq.m.)
2	Three rapid exit taxiways from eiher side of the runway ends in Northern runway	5	Expansion of Cargo Terminal Building to 1,50,000sq.m.
3	Apron expansion for 25 additional bays (4 Code F and 26 Code C)	6	E & M Facilities
		a	Distribution Substation

Appendix Q. - Land area layout



Appendix R: Institutional Structure



Appendix S: State government's approval for TEFR

संख्या: 58/2018/1169/छप्पन-2018-31/16

प्रेषक,

सूर्य पाल गंगवार,
विशेष सचिव,
उत्तर प्रदेश शासन।

सेवा में,

1. अध्यक्ष,
यमुना एक्सप्रेस-वे औद्योगिक विकास प्राधिकरण, गौतमबुद्धनगर, उ0प्र0।

2. मुख्य कार्यपालक अधिकारी,
ग्रेटर नोएडा औद्योगिक विकास प्राधिकरण, ग्रेटर नोएडा, गौतमबुद्धनगर।

3. मुख्य कार्यपालक अधिकारी,
न्यू औखला औद्योगिक विकास प्राधिकरण,
नोएडा, गौतमबुद्धनगर।

4. मुख्य कार्यपालक अधिकारी,
यमुना एक्सप्रेस-वे औद्योगिक विकास प्राधिकरण, गौतमबुद्धनगर, उ0प्र0।

5. निदेशक,
नागरिक उड्डयन,
उ0प्र0, लखनऊ।

नागरिक उड्डयन अनुभाग — लखनऊ: दिनांक: 12 जून, 2018

विषय: जनपद गौतमबुद्ध नगर में जेवर के निकट नॉएडा इन्टरनेशनल ग्रीन फील्ड एयरपोर्ट की स्थापना किए जाने हेतु मा0 मंत्रिपरिषद द्वारा लिए गए निर्णय।

महोदय,

जनपद गौतमबुद्ध नगर में जेवर के निकट नॉएडा इन्टरनेशनल ग्रीन फील्ड एयरपोर्ट की स्थापना किए जाने हेतु मा0 मंत्रिपरिषद की दिनांक 05 जून, 2018 को सम्पन्न बैठक में निम्नलिखित निर्णय लिए गए हैं:-

a. [redacted] कन्सल्टैन्ट प्राइस वाटर हाउस कूपर्स लिमिटेड द्वारा तैयार की गई नॉएडा इन्टरनेशनल ग्रीन फील्ड एयरपोर्ट के विकास के लिए टैक्नो इकोनॉमिक फीजिबिलिटी रिपोर्ट (TEFR) का अनुमोदन (प्रतिलिपि संलग्न)

b. JV Company को incorporate करने के लिए हस्ताक्षरित किए गए MoU का अनुमोदन (प्रतिलिपि संलग्न)

c. नॉएडा इन्टरनेशनल ग्रीन फील्ड एयरपोर्ट के विकास हेतु प्रस्तावित JV Company

2/..

1- यह शासनादेश इलेक्ट्रानिकली जारी किया गया है, अत: इस पर हस्ताक्षर की आवश्यकता नहीं है ।
2- इस शासनादेश की प्रमाणिकता वेब साइट http://shasanadesh.up.nic.in से सत्यापित की जा सकती है ।