Performance analysis of immigration operation at Indira Gandhi International Airport by Queueing model.

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Abstract - This paper study the immigration process at Indira Gandhi international airport and how we can use queueing model to make immigration process more comfortable in less time consuming.

Keyword - Immigration, Queuing theory

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INTRODUCTION

- **Population**-Population, particularly Indian population has aroused growing interest across the globe in recent year. The world population has started increasing rapidly in the twentieth century. If we keep on eye about India. India is a one on the developing country. The population count for 1867-1871 was 203.4 million it increased 9.4 % in 1889-1891 and in 1910 5.7%. India`s population

- **History of Air transport** - Aviation History of India – The Early Beginnings – The great business of air transport was born in India on the 18th of February 1911 and first mail flight took place. The Indian aviation market is on high growth path. As per IATA (International Air Transport Association) the number of global departures during calendar year 2018 is projected at around 4.3 billion. India among the top seven aviation market with 187 million passengers. India is as one of the fastest growing economies of the world and is likely to become the fifth largest in 2019.

- **The Growth Driver**- India growing Aviation Market-According to the international air transport association (IATA). India is the fastest growing aviation market currently. Bangalore is the aviation manufacturing hub in India. Today global air lines consist of more than 2000 airlines. That are operating 23,000 aircraft.

- **Queuing theory**-Queuing theory had its beginning in the research work of a Danish engineer named A. K. Erlang in 1909 Erlang experimented with fluctuating demand in telephone traffic. There are many solutions

we have made like for traffic jam we have widen road. If there is runway for airport, we have more runways but still there is problem.

So, in queueing system we solve this problem mathematically so we make model. Before This we will know the generic term.

The input processes

- **Balking**- A customer may decide to wait no matter how long the queue becomes. if a customer decides not to enter the queue because of its huge length. he is said to have balked

- **Reneging**- A customer may enter the queue, but after some time loses patience and decide to leave. this is called reneging

- **Joking** - In the case when there are two or more parallel queues, the customer may move from one queue to another for his personnel economic gain it's called joking

The Queue Discipline

A rule according to which customers are selected for service when a queue formed. The most commonly used laws are

- **FIFO** - First in First Out: who comes earlier leaves earlier, FCFS - First Come First Served

- **LIFO** - Last Come First Out: who comes later leaves earlier, LCFS - Last Come

First Served Performance Measures of Queueing Systems To characterize a queueing system we

have to identify the probabilistic properties of the incoming flow of requests, service times and service disciplines. The arrival process can be characterized by the distribution of the interarrival times of the customers, denoted by A(t), that is A(t) = P (interarrival time < t).

Immigration and custom- The Immigration an important process for security purpose. in the immigration inspection first is Documents review which includes passport, Visa, Immunization certificate, Documentation, Letter of confirmation or support. Second- standard questions like what is the nature of visit? How long do you plan to stay in the country, third finger print and photos, Fourth- After Approval put an official stamp. Some passengers choose for second level inspection for more information

(i) "secure implementation in queueing problem" Katsuhiko Nishizaki

Theoretical Economics Letters, 2012, 2, 561-565 http://dx.doi.org/10.4236/tel.2012.25103 Published Online December 2012 (http://www.SciRP.org/journal/tel) Objective of this paper is to consider queueing problems of allocating position in a queue to agents each of whom has a constant unit waiting cost with monetary transfers. Result shows that it is difficult find such conditions that are reasonable in the economic sense.

(ii) Approximate Analysis of an M/M/1 Markovian

Queue Using Unit Step Function Dhanesh Garg Department of Mathematics, Maharishi Markandeshwar University, Ambala, India. In this article the incoming arrivals are Poisson stream; service time is exponentially distributed and the first-come first-served queueing discipline presented. the transient behaviour of the M/M/1 queue is very important for practical applications in this paper they obtained the analytic transient solution of M/M/1/N queuing system with a time-dependent arrival rate.

Indira Gandhi International Airport, Delhi.

Indira Gandhi International Airport Indira Gandhi International Airport (IATA: DEL, ICAO: VIDP) is the primary airport of the National Capital Region of Delhi, situated in West Delhi, 16 km (10 mi) southwest of New Delhi's city centre. Named after Indira Gandhi, the former Prime Minister of India, it is the busiest airport in India in terms of daily flight traffic and second busiest in term of passenger traffic in India after Mumbai's Chhatrapati Shivaji International Airport. With the commencement of operations at the new Terminal 3, Delhi's Indira Gandhi International Airport has become India's and South Asia's largest and most important aviation hub [86]. It became India's and South Asia's largest aviation hub, with a current capacity of handling more than 62 million passengers. The planned expansion program will increase the airport's capacity to handle 100 million passengers by 2030. [87]

Quick Facts About Indira Gandhi International Airport

1. The Delhi airport scored 4.90 on a scale of 5 points measured by 300 members of the ACI ASQ benchmarking program

2. As many as 40 million passengers used the IGIA to reach 58 domestic and 62 international destinations in 2014-2015

3. IGIA hosts six domestic carriers, 56 international carriers and also has the capacity to handle the gigantic Airbus A380 aircraft

4. The airport was operated by the Indian Air Force before its management was transferred to the Airports Authority of India. In May 2006, the management of the airport was passed over to Delhi International Airport Limited (DIAL), a consortium led by the GMR Group [88].

IATA Code: DEL Year of Establishment: 1962 Hub For: Air India, Air Asia India, Alliance Air, Go First, Indigo, Vistara, Zoom Air, Spice jet, Qui Jet Airlines.

Services & Facilities: Free WIFI, Mobile Charging Stations, Duty -free Shopping, Lounge Area, Baby Care Facilities, Gaming Area, Foods and Beverages, Medical Services, ATMs, Currency Exchange, Smoking Room, Shower Room. Prayer Room, Luggage Lockers, and Hotels in transit [89].

RESEARCH METHODOLOGY

Passengers Statistics: Around 40 million (2021-2022) Delhi airport has bettered its ranking from 13th in 2021 and 17th in 2019. Delhi airport witnessed a collective footfall of passenger traffic of over 5.94 crore in 2022 as per the ACI report," it said.

According to ACI, the top 10 airports for total passenger traffic, representing 10 per cent of the global traffic, witnessed a gain of 51.7 per cent from 2021 amounting to 85.9 per cent recovery vis-à-vis their 2019 results.

ACI noted that preliminary figures indicate that with the resumption of international travel, 2022 global passenger traffic reached close to 7 billion, representing an increase of 53.5 per cent from 2021, or a 73.8 per cent recovery from 2019 results. [90]

History Delhi Airport

The airport, located in the Palam area of Delhi, was initially known as Palam Airport before being renamed in 1986 in honour of Indira Gandhi, the former Prime Minister of India Airport Terminals Information

The airport has three terminals: Terminal 1, Terminal 2, and Terminal 3. Terminal 1 is the oldest

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and is used for domestic flights by airlines such as Air India, GoAir, IndiGo, and SpiceJet. Terminal 2 is used for international flights and is operated by airlines such as Air Arabia, Air France, British Airways, and Qatar Airways.

Terminal 3 is the largest and busiest terminal and is used for international flights by airlines such as Air China, Cathay Pacific, Emirates, and Lufthansa. It has been ranked as the eighth-best airport in the world by Skytrax [91]
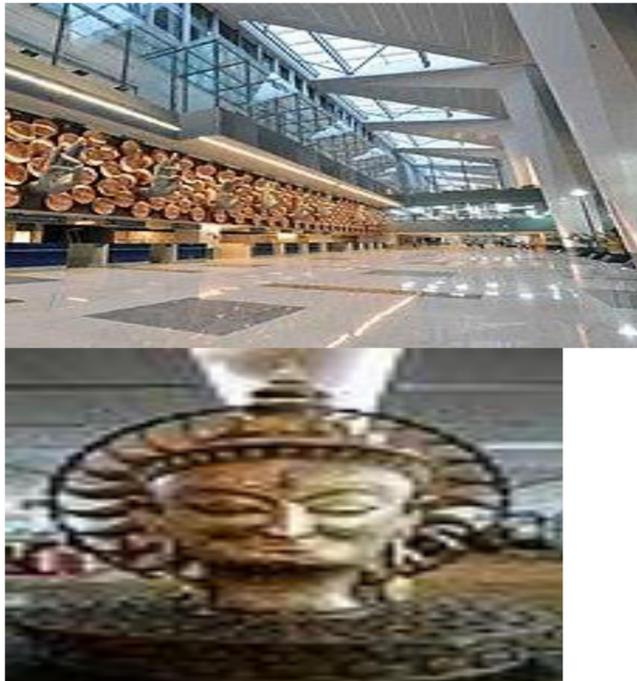
Sculptures in Terminal 3: Hindu solar deity Surya (upper left), Surya Namaskars asanas (upper right), *hasta mudras* or hand gestures extending from a wall over the immigration counter

Statistics: International Passenger Traffic Data Indira Gandhi International

Passenger Traffic

In Million	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
International	20.7	25.1	22.8	24.2	27.5	34.3	42.2	48.3
Domestic	9.3	10.8	11.6	12.7	13.5	14.21	15.5	17.5
Total Passenger	29.9	35.9	34.4	36.9	41.0	48.4	57.7	67.7
Growth(YOY)%	14.6	19.8	-4.2	7.3	11.1	18.1	19.2	13.8

Passenger Traffic Share In %

Domestic	69.0	79.0	66.3	65.6	67.0	70.8	73.1	73.5
International	31.0	30.0	33.7	34.4	33.0	29.2	26.9	26.5

Percent (%) Of Passenger traffic handled by DIAL in Comparison with all Airport

Domestic	19.6	20.7	19.6	19.8	19.7	20.3	20.51	9.9

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ANALYSIS OF THE POPULATION BY THE QUEUING THEORY

The passenger arrival rate is unexpected at international airport. Arrival of passengers Varies it depends upon time to time. Due to this heterogeneity factors an airport queue system performance varies many times in a day.

Several observations, steps and approximation have to be set before solution which are as follows.

1) The thesis has to focus on the departure process of international flights at international terminal of international airport.

2) Data collection is based on one day all international flight of international terminal.

3) Data is representing all the international flight on international terminal of 5 different international airport of India comparison between previous result and after new solution is presented in tables below.

4) The POM-QM software has been used to solved the process of immigration at international airport. Which may help passengers to reduce consuming time during immigration process.

POM-QM for window (also known as POM for windows and QM for windows). This package is the most user-friendly software package available in the fields of production and operations management, quantitative methods, management science, or operations research. The software can be used either to solve problems or to check answers that have been derived by hand. POM-QM for windows contains a large number of models, and most of the homework problems in POM-QM for windows standardization The graphical user interface for the software is a standard windows interface. Anyone familiar with any standard spreadsheet, Word processor, or presentation package in windows easily will be able to use the software. This standard interface includes the customary menu, toolbar, status bar, and help files of windows programs. Even though the software contains 29 modules and more than 60 sub models, the screens for every module are consistent, so, after you become *RESULT ANALYSIS*

Passengers' data of Indira Gandhi International Airport Date 29/06/2023 data collected by https://delhiairport.com. There are near about 170 international flights in a day on 29/06/2023 by this we can predict approximate flight per day at Indira Gandhi International Airport. Many international flights are connected with international Indira Gandhi Airport. Total passenger is 39,096Approx. If we divide a whole day in four parts of the day

(i) 00:00hr to 06:00hr passenger count is 10,118.

(ii) 06:00hr to 12:00hr passenger count is 8654

(iii)12:00hr to 18:00hr passenger count is 7560

(iv) 18:00hr to 24:00hr passenger count is12764

It is observed that passenger count is different by this data we observe that in these four parts of the day there are differences between no of passengers

Table 1a Actual Scenario for Immigration Process for Indira Gandhi International Airport

Time	Total Passenger	Passenger Arrival per minut	Average arrival Time (λ)	Average service time	Passenger serve/6h(μ)	No of server	Server utility(λ/μ)
00:00-06:00	10,118	28.10	12.81	20m/p	18	95	0.71
06:00-12:00	8,654	24.10	14.98	20m/p	18	95	0.83
12:00-18:00	7560	21	17.14	20m/p	18	95	0.95
18:00-24:00	12,764	35.45	10.15	20m/p	18	95	0.56

2b-Proposed solutions for Immigration Process for Indira Gandhi International Airport.

Time	Total Passenger	Arrival Rate (λ)	Service rate(μ)	No of server required	Server utilisation(U)	Queue Length(L)	System Queue length (L)	Wait time in line (L q)	System waits time (wq)	Probability All server ideal	Efficiency
00:00-06:00	10,118	28.10	18	17	0.71	1.56	0.055	1.28	4.54	0.20	0.09
06:00-12:00	8,654	24.03	18	16	0.83	1.335	0.055	1.27	5.29	0.26	0.08
12:00-1800	7560	21	18	12	0.95	1.166	0.055	4.93	2.35	0.31	0.09
1800-2400	12,764	35.45	18	20	0.56	1.96	0.055	5.36	1.51	0.13	0.09

CONCLUSION

We have developed the queueing model under Heavy traffic environment and made its intensive studies. The Immigration process in a country like India is complex process. One of the main reasons is heavy population load. Almost various performance measures obtained have been have been tabular form. We have made optimisation of indistinct queueing systems for its optimal number of servers with respect to minimization of time consumption of traveller. The entire process becomes faster.

A cost examination must be done in order to determine the cost practicability of increasing the number of servers during peak times.

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