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Application of operations research in the Indian Aviation Industry

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ABSTRACT

The aforementioned paper is an attempt to understand the aviation industry in India and address its most common problems. India is said to have higher growth percentages in the sector compared to any other country in the world along with managing the busiest airports in the world In Mumbai and Delhi, in terms of a number of passengers and Number of flights flying in and out during the year. This niche approach helps us understand what flyers are most dissatisfied within their overall flight experience and provide possible solutions. This is an industry which traditionally tends to operate on very thin margins. Considering the tremendous pressure that's been building on them in terms of growth in frequency of flights, a number of flyers and high fuel prices, it's important to sustain what's under their control, and their clientele qualifies as the most important element.

Keywords— *Aviation Industry, Queuing theory, Mumbai Airport, Delhi Airport, Theory of proxemics, Primary research*

1. INTRODUCTION

The Indian Aviation Industry is facing challenging times. Despite a remarkable CAGR of 20.5% from FY15 to FY18 (Financial Express), a favorable macroeconomic environment, and development of airports, the problem of high costs persists. Operating margins of airlines have taken a hit. Many operating expenses such as fuel, operating lease payments, and repair/maintenance are dollar-denominated, implying they are subject to currency fluctuations and are often beyond the control of airlines. The recent depreciation of the rupee spells further bad news for them. Losses in the aviation sector are expected to reach as high as **INR 88 billion** in FY19 (livemint.com/opinion). Jet Airways is an example of the loss situation which is prevailing among airlines.

Airports have their own problems too. The overall flight experience has definitely improved over the years, but there are issues which are causing passenger dissatisfaction such as increases in processing times, issues regarding in-flight comfort, and even issues with regard to airport parking. An article from January 2018 mentioned how **immigration times have almost doubled** in Indian airports (The Times of India, 2018). Mumbai Airport became the world's busiest single-runway airport in 2016-17 as well as the busiest in terms of passengers, with 45.2 million people flying in and out per year. (Economictimes.indiatimes.com)

However, what is worrying is that this growth has been quite unsustainable as mentioned previously. It is imperative for the aviation sector to focus on factors they can control, which is primarily from the *customer's* side.

2. LITERATURE REVIEW

Major problems in the aviation industry at the customer level and vague solutions have been offered, but these provide a foundation on which scientific study can be conducted. For example, seating since the 80s has seen a major change, with the increase in the commercial nature of flight. Leg-room has seen a decrease in many airlines which has affected in-flight comfort (**Marshall,2017**). Lavi Industries is a private company dealing in customer-based solutions such as queue management systems and staffing issues. They implemented a new technology, Qtrac **(Lavi Industries, 2018)**, which offers automated solutions to

decreasing waiting time in queue situations. This provided our paper with a foundation on which to understand variables which go into the service process. There has not been extensive research performed in the concerned field.

Qtrac uses OR techniques such as queueing theory to calculate waiting times, store this data, and predict future situations to improve customer flow and reduce costs to airports and passengers alike. This case is helpful to our paper as it helps us understand the queue problem and the ways it can be dealt with. ()With the massive growth in the airline industry in recent times, reducing costs and being more efficient is key. This research papers objective is to showcase how operations research has helped the airline industry grow by leaps and bounds. It also assesses the upcoming challenges and barriers that the industry might face in the future. The paper shows how every aspect of this industry utilizes OR. OR is used in scheduling aircraft and crews in order to reduce the loss of human efficiency and improper utilization of resources. Even for maximizing revenues, OR is utilized. Lastly, for building and maintaining the infrastructure required b the industry is only taking forward after OR applications. Thus, the growth can be attributed to OR. OR will play a major part in the future of this industry as well. **(Cynthia Barnhart, Peter Belobaba & Amedeo R. Odoni).**

Air traffic is seeing an increasing trend worldwide which in turn is creating situations of critical capacity and traffic congestion, both of which cause airline delays. 'Queuing theory' can be used when an approximate estimate is needed for the number of delays suffered by airlines. A model was proposed wherein, the first phase would constitute the web check-in with baggage, the second phase would be web security screening of passengers and cabin bags and the third would be the generation of a mobile bar code for boarding with a smart boarding pass. This theory can help to ease out customers' waiting time by reducing the length of queues which would also facilitate to increase customer satisfaction. **(Nityangini Jhala, Pravin Bhathawala)**

It is important to create knowledge about the perceptions that are subjective with respect to passengers having a comfortable experience in flights. Seven emotions are identified as significant for a passengers experience to be comfortable. They are as follows - satisfaction, frustration, relief, joy, reproach, gratitude and hate. Of these seven emotions, the emotions that a passenger experiences during his flight, assess the inflight conditions as comfortable or not. Physical well-being has been rated as the most essential aspect for a passenger to have a comfortable flight. The experiences in a flight, with conditions such as adequate legroom, optimum temperature and pressure have helped the passengers have a positive emotion with respect to comfort**. (Naseem Ahmadpour)**

3. SIGNIFICANCE OF RESEARCH

Our research paper focuses on subjective and qualitative *micro* factors which play a big part in determining passenger satisfaction and improving the overall flying experience. Airlines and airports must focus their energy on making the process as smooth as possible so that **the image of air travel is not sullied.** Global air traffic is expected to grow by around 7% in 2018, following an 8% growth in 2017, which emphasises the need for conducting research about sustainable growth in aviation.

4. METHODOLOGY

Primary Research with a sample size of 218.

4.1 Analysis finding

Under the primary survey that we undertook, following were the results that we got are:

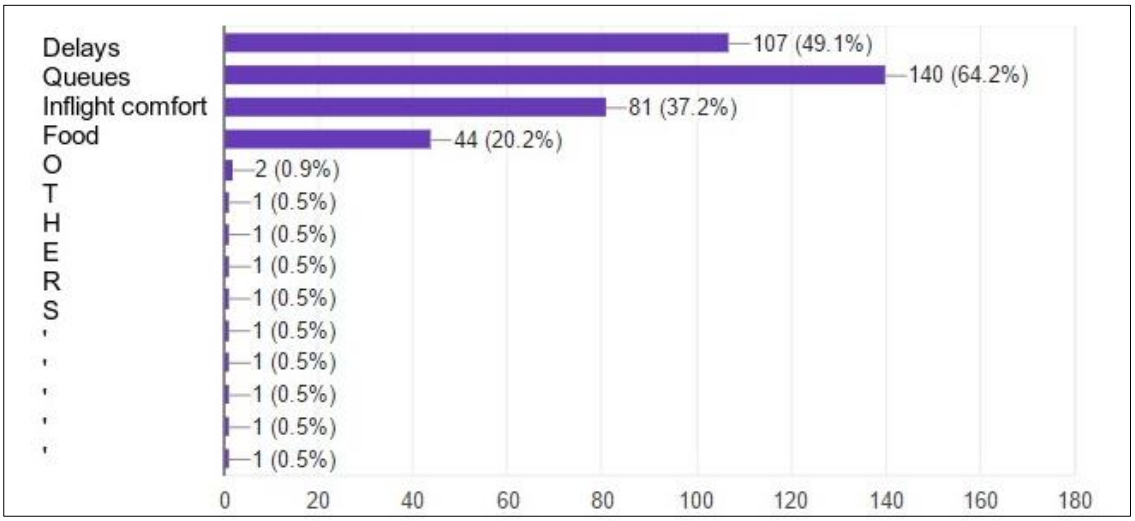

Fig. 1: Graph showing responses of people when asked about the problems faced when the decide to fly

Our primary survey had a sample size of 218 responses. Queues were observed as the major problem followed by delays and inflight comfort. In our research paper, we have tried to solve the problems of queues, inflight comfort, and food. As delays are subject very dynamic situations we weren't able to solve this issue. During the primary survey, it was found that 37.5% of the total sample size finds the inflight comfort to be lacking. Sometimes airline companies try to maximise their profits at the cost of passenger discomfort. Most of them have experienced some level of discomfort on an aircraft, and if you're stuck in the economy for a transatlantic flight from Europe to New York or beyond, the journey is rarely pleasant. Problems like discomforting seats, less legroom, wrong posture, and constantly irritating noise are the major reasons for the lack of in-flight comfort.

From the perspective of the Airlines companies, it is but obvious that they would try to maximise their profits at the cost of customer dissatisfaction.

To determine the price of the ticket, the airlines first determine the type of the plane thus determining how many seats each class accommodates. First, business, premium economy, and economy are the four classes from which you can select the type of ticket. Restrictions and rule are there for each booking class. The rules relating to change in tickets or refund are very stringent at times, and sometimes you get more recurrent flyer miles or nothing at times. Hence, the result being that each booking class has different prices affecting the overall flight profits. Even if there are 100 seats in economy, there may be only 20 seats in each different fare bucket.

Owing to such dynamics it is but obvious that consumer satisfaction has declined over the years. To list down the major discomforts that were found during the survey were the posture of seating, seats, food quality and congestion during exits. Owing to such situation we have tried to carve out a balanced way to solve the above mentioned problem.

The major problem that was countered was related to the seats, legroom, and congestion in seating.

It's a shock to see how little legroom is permitted for the economy, no matter how frequently they fly. The ongoing trend of physically squeezing in as many passengers possible started in the late eighties. The New York Times reported that manufacturers for the first time started to cut seat pitch in the economy from an industry average of 36 inches to just 32 inches! For the long haul airlines, this meagre leg room becomes a huge discomfort. Also in the primary survey, congestion I the economy class was seen as the biggest problem.

Owing to such problems we have tried to design a simple OR model which would help to solve the above mentioned problems.

Using the 'Theory of Proxemics', which means the distance surrounding a person forms a space. The space within intimate distance and personal distance is called personal space. The space within social distance and out of personal distance is called social space. And the space within public distance is called public space.

So, in an airplane where congestion has become a big issue, the seating arrangement, especially in the economy class, can be designed in a manner where a person won't feel claustrophobic and congested.

A working design can be made using the intimate distance. The area which a person should at least get can be derived by allocating an area of a semicircle with a radius of at least 1.5 feet. The reason for 1.5 feet is that it's the minimum distance which brings the person into the personal space from the intimate space.

This could be worked out by dividing the floor area for the economy seats with the area of a semi-circle of 1.5 feet. Also the area for leg room of 32 inches which is the industry.

4.2 Queuing problems

Delay in Processing Time, according to the results of the primary survey conducted, respondents selected "waiting time in queues at various airport checkpoints" as the number one problem which they face during their flying experience.

Why do problems arise with regard to waiting in lines?

A "queueing problem", as it is so called, arises when a service counter has to service numerous customers, who arrive in a particular order (or even at random). The customers have to wait for their turn as in most cases, the performance of the service takes more time than the arrival rate of the customers. **Queueing Theory is a technique in Operations Research** used to help devise solutions to this problem.

We will be focusing on two important areas where passengers at airports must wait in line: at immigration and at the preliminary check-in.

Given below is a generic queueing example which can help explain how an immigration line would work (all times in minutes):

Inter-arrival times	P[E]	Cum P[E]	Service times	P[E]	Cum P[E]
1	50%	50%	1.00	55%	55%
2	35%	85%	of airports,	35%	90%
4	15%	100%	4.00	5%	95%
			5.00	5%	100%
	Opening time:	**8:00**			
	Passenger	Random number for inter-arri	Time (minute)	Arrival time at	Servicing starts at
	1	88	4	8:04:00 AM	8:04:00 AM
	2	13	1	8:05:00 AM	8:07:00 AM
	3	59	2	8:07:00 AM	8:11:00 AM
	4	51	2	8:09:00 AM	8:14:00 AM
	5	10	1	8:10:00 AM	8:15:00 AM
	6	40	1	8:11:00 AM	8:16:00 AM
	7	95	4	8:15:00 AM	8:17:00 AM
	8	42	1	8:16:00 AM	8:22:00 AM
	9	23	1	8:17:00 AM	8:23:00 AM
	10	69	2	8:19:00 AM	8:24:00 AM

			Waiting schedule (minutes)	
Random number for se	Service time	Ends at	Customers	Service counter
75	3	8:07:00 AM	-	4
94	4	8:11:00 AM	2	
63	3	8:14:00 AM	4	
3	1	8:15:00 AM	5	
2	1	8:16:00 AM	5	
42	1	8:17:00 AM	5	
99	5	8:22:00 AM	2	
14	1	8:23:00 AM	6	
32	1	8:24:00 AM	6	
37	1	8:25:00 AM	5	
		Total waiting time	**40**	
		Average waiting time per custom	**4**	
		Service counter idle time	**4**	

Fig. 2: Queuing example

4.3 Information about the sum

- For simplicity, it is assumed there is only one servicing counter and 10 passengers are being serviced. However, the problem works with any number of passengers.
- The servicing counter begins operations at 8 am in the morning.
- There is an inter-arrival time, which refers to the time gap between the arrivals of two passengers. Service time is the time taken to process one passenger.
- It is assumed there are limits on both the inter-arrival times as well as on service times. It should be noted that this is for simplicity and to make the concept clear to the reader.
- It is assumed there is a limit on inter-arrival times as well as service times i.e there is a cap on how high the times can go.

The aim of the numerical is to calculate the waiting time per passenger (before service rendered), and also to calculate service counter *idle time*, which is when the counter is operational but there are no passengers to service. Probabilities are taken to predict the likelihood of deviations occurring that is disruptions in the flow of passenger traffic which increase wait times.

Some events which would cause times to increase are:

- Formality related issues. This tends to be the most common cause of hold-ups based on questions we asked the respondents. This includes passengers not having the correct documentation/identification, problems while filling up forms, etc.
- Communication issues which could arise due to language barriers. Disagreements due to disgruntled passengers/officials which leads to further delays.
- Lack of service counters. In India, there exists the problem of unoccupied counters which leads to concentration of passengers and increased workload for officials.

4.4 Solutions to the queue problems

Since the average waiting/idle time can be reduced by reducing the probabilities of higher inter-arrival times and service times, we can propose the following solutions:

- Detailed messages sent by airlines stating information such as documents to be carried, time to arrive at various terminals, etc. This would help reduce inter-arrival times which in turn would reduce the probability of service counter idle time. Hire translators during peak days to help reduce communication barriers when it comes to foreigners. This would have the added benefit of garnering goodwill for the airport.
- Job rotation system wherein employees in the airports with slack hours (i.e those working in shops, etc with lean periods) are trained for the immigration process and can cover empty service counters, which tends to be a serious issue in our country. The employees would be compensated for their added efforts. A similar incentive system could work for night shift employees, a time when fliers tend to be jet-lagged and would prefer the shortest possible waiting time.
- Airline tie up system wherein the *airline* offers to pre-verify passengers' documents so as to reduce service times at the counters (the officials would need to simply stamp the documents). The airline would offer a price rebate to customers to sign up for their plan and in return could get a commission from the airport for expediting the process. The airline receives goodwill as well.
- Automation. In airports such as Singapore Airport, the preliminary formalities such as processing of passports, etc are performed by machines. The chances of human error are wiped out and processing time is reduced. In India, such systems must be implemented. There are infrastructural constraints, but the upside of such systems are huge.

Other waiting situations like preliminary check-in counters can be dealt with in similar ways. Some airports already segregate lines when there are hold-ups due to baggage issues and documentation problems.

5. CONCLUSION

The airline industry faces a multitude of problems just like any other industry. Many of these problems are common to all and lead to the hindered growth of the industry. Howsoever, we have discovered that many of these problems can be solved using theories of operations research and with an understanding of the variables in micro situations. These theories can help reduce the problems and excessive costs related to the airline industry. In our opinion, Operations Research is not given enough importance in the industry. Many issues that people face relate to factors like long queues and discomfort. Our paper has shown how OR can help overcome these problems and thereby provide a better experience for the customer. Costumer centric solutions are the need of the hour and they must be devised by all companies in the sector. If it's implemented correctly it will help the industry grow by leaps and bounds. Thus a scientific approach is required if the airline industry wants to continue having the same growth rate as it has enjoyed in the recent decades.

6. LIMITATIONS

The following are the limitations of this research paper: The nature of the implementation, of the method of data collection, may be flawed as we do not have enough experience in primary data collection. Our sample size was only 218. This is too small with respect to the actual number of people traveling by flights in India. The importance of sample size is greater in a quantitative study than in a qualitative one, therefore, there is a possibility of a more accurate result if our study was based on a much larger sample size. Also, previous studies form literature findings which are used as a foundation for researchers. There wasn't enough prior research done on the 'comfort in flights' aspect of our research paper.

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