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Rationing Aircraft Orders - A strategic Solution to Long Order Book at Maximum Profit Margin

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Abstract: **Two burning issues of today's aircraft OEMs are Long order book entry under very less profit margin and loosing sailing power to powerful buyers are addressed in this model as single point solution. In current scenario most of the aircraft orders are considered on the first come first serve basis and rejections are carried out in long running negotiation table. This scenario dragged today's industry under these two issues. This model will gradually help the strategic team to take acceptance or rejection of an order on instant basis supported by long statistical order history data and future forecast in statistical platform or at least will give enough confidence on negotiation table to the selling side. This model will also be able to gradually build up the market power to the OEMs from high profile buyers for the sake of a stable future of aircraft industry.**

Keywords: **Rationing Aircraft Orders, OEMs.**

1. INTRODUCTION

The industry of Aircraft manufacturing is a special business case of supply chain example having its own unique characteristics as follows:

1. One of a kind of product having lead time of 4 to 12 years, life span of 30 to 45 years and design phase of about 8 to10 years.

2. Profit margin reduces drastically on moving up along the chain starting from small part manufacturers and tire 4, tire 5 suppliers to aircraft manufacturers and then the Airlines. In this chain Aircraft manufacturers such as Airbus, Boeing and others are having a profit margin of about 6% on average which itself is a pain.

3. Aircraft manufacturers are always running with a huge order book back logs which drastically reduce the market potential of the OEMs as far as customers business is concerned. Huge order backlog leads long lead time for order delivery, resulting more orders than required for full filling passenger requirement from Airlines and Lessors. This in turn leads more cancellation followed by opaque visibility of supply demand curve of the Aircraft manufacturer.

4. Irrational demand for aircrafts at the initial phase of lifecycle is misleading the company strategies.

5. Market dynamics is imbalanced because the same product, that is aircraft, is having different B2B dynamics as the potential customers are having different business scenarios. The Airlines are buying the airplane as an operating resource, Leasers are buying it as financial resource, and Investors are buying it as business resource and so on. Hence the same sailing model cannot be adopted for all kind of customers which may create a future market void of long term business relations. By the time in this kind of business scenario, if the orders are not restricted, market power will gradually shift from Aircraft manufacturers to lessors and investors or some time giant Airlines with big order catalogue.

To address these issues a single solution node is provided in this paper which is Rationing of orders in such a way that all the above mentioned issues have been addressed from a single optimization measure. For the same, 3 filters have been proposed as given below:

A. Dynamic Stochastic Capacity Rationing

B. MRP Rationing

C. Lead Time Rationing

All these 3 have been incorporated in a single input single output stochastic dynamic model. It can be used as a supporting tool for the negotiator on the table with customer with a crystal visibility about the future consequences of accepting or rejecting the proposed order under given clauses.

2. DSCR DECISION PROCEDURE

When expected demand is more than available capacity, a make-to-order manufacturer should take the more profitable orders and reject the less profitable orders in order to better allocate its limited capacity and maximize its profit. However, various orders will arrive at different times in the future so the manufacturer cannot look at all the order inquiries at the same time and choose the most profitable ones. When an order inquiry arrives, the manufacturer must promptly determine, without knowing exactly what the future orders might be, whether to accept the order or to reject the order, thus reserving the capacity for future more profitable orders.

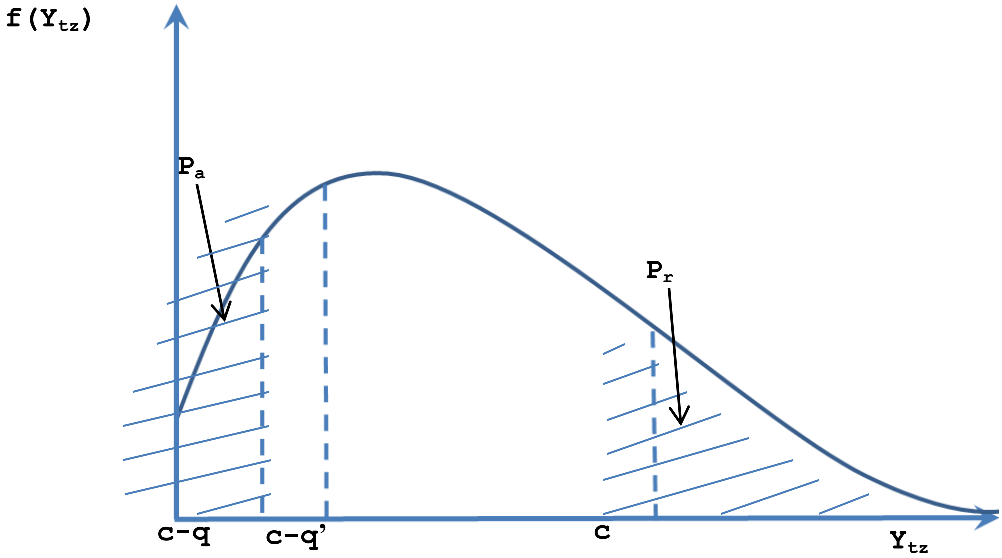
There are 2 assumptions that have been taken into account for the initial part of the mathematics.

(1)The arrival of future customer orders is a Poisson process;

(2)The capacity requirement of a future customer order is a continuous random variable; and

(3)The profit per unit capacity used by an order is also a continuous random variable.

When an order inquiry is received, an acceptance-or-rejection decision can be made based on the computation result of the DSCR procedure outlined in the following. If the capacity requirement q of an order with profit z exceeds the current available capacity c, the order is rejected and no further computation is required. Profit z of a current arrival order inquiry is assumed as a known input parameter in the original DSCR approach. However, in an order negotiation process, the price of the order that affects its profit is initially unknown. Let α be the probability of a random order having a higher profit than the current inquiry order; then, $\alpha = P\{Z \geq z\}$. Let t be current time and T be the end of order arrival process. According to the property of Poisson process, the distribution of the random variable of the number of more profitable orders arriving within the interval (t, T] is a Poisson distribution with parameter $\alpha\lambda(T\text{-}t)$ Let $Y_{tz} = Q_1 + Q_2 + \ldots + Q_N$ be the total capacity requirement of future more profitable orders, where N is the number of more profitable orders arriving in the future and a random variable with Poisson distribution with parameter $\alpha\lambda(T\text{-}t)$. Here, the probability density function of Y_{tz} can be calculated by conditioning random variable N, which is the number of order in the interval (t, T]. This leads to given the current available capacity c, let R1 be the event that the total capacity requirement of future more profitable orders is greater than c. Let R2 be the event that rejecting current order inquiry is a correct decision. Under the condition that the total capacity requirement of future more profitable orders is greater than the currently available capacity c (i.e. event R_1), rejecting the current order inquiry is a correct decision (i.e. event R_2). Therefore, events R_1 and R_2 are equivalent, and their respective probabilities, namely, $P(R_1)$ and $P(R_2)$, are equal. Let $p_r = P(R1)$ be the probability of event R1, which is the area under the curve of Y_{tz} between c and 1. Since $P(R_1) = P(R_2)$, p_r is also the probability that rejecting the current order inquiry is a correct decision. In addition, given the capacity requirement of the current order inquiry q, let A_1 be the event that the total capacity requirement of future more profitable orders is less than c – q. Let A_2 be the event that accepting current order inquiry is a correct decision. Under the condition that the total capacity requirement of future more profitable orders is less than c – q (i.e., event A_1), accepting the current order inquiry is a correct decision (i.e., event A_2). Therefore, events A_1 and A_2 are equivalent, and their probabilities $P(A_1)$ and $P(A_2)$ are equal. Let $p_a = P(A_1)$ be the probability of event A_1, which is the area under the curve of Y_{tz} between 0 and (c – q). Since P(A1) = P(A2), pa is also the probability that rejecting current order inquiry is a correct decision. By letting $\theta = \alpha\lambda(T\text{-}t)$ p_r and pa can be respectively computed as follows:



$$p_r = P\{c \le Y_{tz} \le \infty\} = \int_{c}^{\infty} f(Y_{tz})dY_{tz} = \sum_{n=0}^{\infty} P\{c \le T_{tz} \le \infty \mid N = n\}P\{N = n\}$$

$$= \sum_{n=1}^{\infty}\left\{\left[\int_{c}^{\infty} \frac{1}{\sqrt{2\pi n\sigma_q}} exp\left(\frac{-(Y_{tz} - n\mu_q)^2}{2n\mu_q^2}\right)dY_{tz}\right] \times \left[\exp(-\theta)\frac{\theta^n}{n!}\right]\right\}$$

$$p_a = P\{0 \le Y_{tz} \le c - q\} = \int_{0}^{c-q} f(Y_{tz})dY_{tz} = \sum_{n=0}^{\infty} P\{0 \le T_{tz} \le c - q \mid N = n\}P\{N = n\}$$

$$= \sum_{n=1}^{\infty}\left\{\left[\int_{0}^{c-q} \frac{1}{\sqrt{2\pi n\sigma_q}} exp\left(\frac{-(Y_{tz} - n\mu_q)^2}{2n\mu_q^2}\right)dY_{tz}\right] \times \left[\exp(-\theta)\frac{\theta^n}{n!}\right]\right\}$$

If p_a is less than p_r, the current order is rejected; otherwise, the order is accepted and the current available capacity is updated by (c – q).

Pricing and Lead time Rationing:

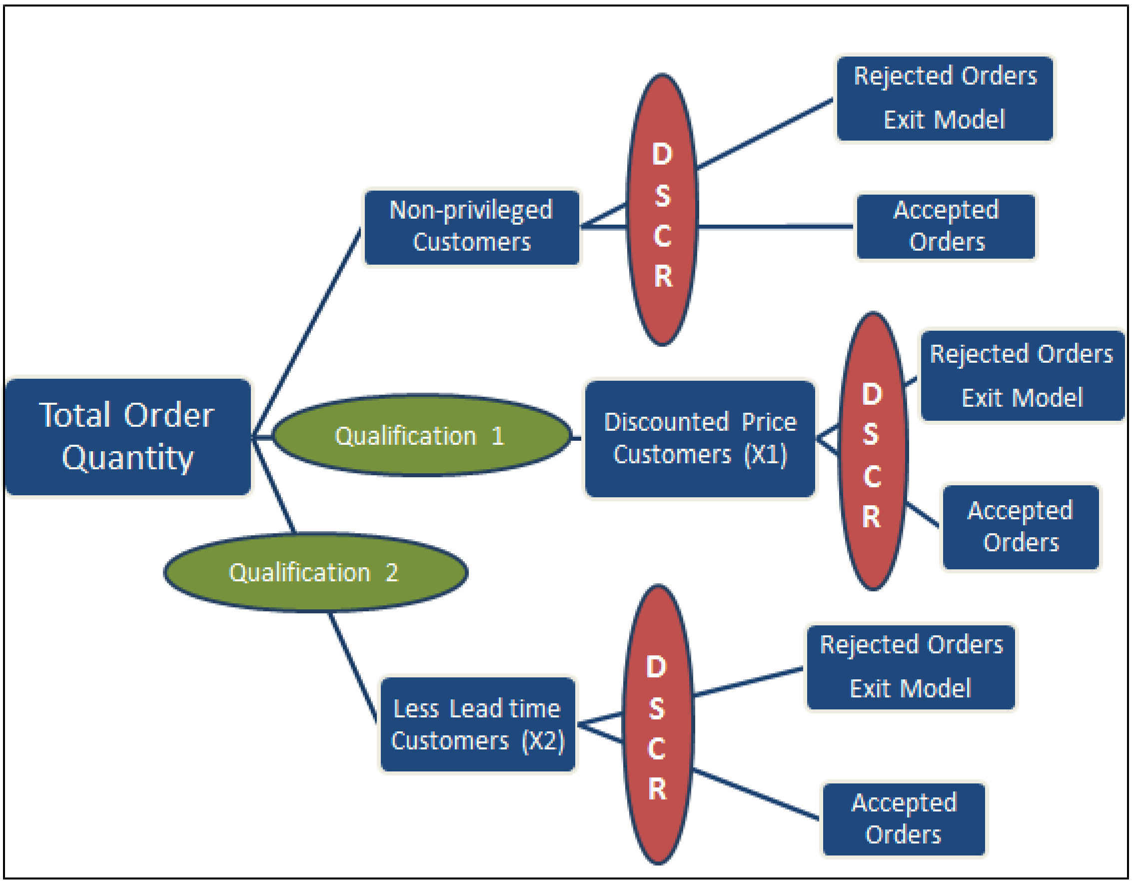
These 3 filters discussed above naming DSCR, MRP rationing and lead time rationing should be accommodated in the model in parallel. That means the qualification filters will be placed in front of the global Aircraft market and will test each individual order enquiry under the developed algorithm to filter it in.

In the process, the algorithm will define a high boundary value of the cut off profit (higher than Ƶ) to treat the initial non-segmented orders. The surplus capacity will then be distributed in the privileged segment of the market for better future strategic market balance.

High Boundary Profit:

In this segment we will set our boundary profit value at a higher threshold than the usual one.

In the DSCR approach we define a parameter *α* called probability of profit per unit capacity for a future random order arrival is higher than that of current order inquiry *z*. When an order inquiry is received, the capacity requirement *q* of the current order inquiry and current available capacity *c* are known. P_a is the probability that accepting the current order inquiry is a correct decision and P_r is the probability that rejecting the current order inquiry is a correct decision. The most conservative boundary value of profit per unit capacity for the future orders will be Ƶ for which in the probability density function curve the probability $P_a = P_r$. That means the value of profit will be such that the probability of acceptance of the order and probability of rejection of the order remains same. Let's say the incremental value at boundary profit be ƶ. Hence the final boundary value is Z = (Ƶ+ ƶ). ƶ is called the correction factor above the marginal profit derived from probability density curve. This correction factor comprised of 2 different effects coming from *lower pricing* and *lower lead time* proposition to selected buyers depending on the strategic stand point of buyer's asset utilization model and future market balance. Bulk order discounts are not going to be a part of this model and can be decided on negotiation table later on. Ideally the quantity of products sold at boundary profit margin of Ƶ is c and at Z be c'. Now as par the definition *c* must be greater than c'. On the other hand c is the maximum capacity produced by the organization which is getting sold completely at boundary profit margin of Ƶ giving maximum utilization. Once after increasing the profit margin by ȥ the total quantity sold at the end of period T will be c'. The difference of quantity is having an open market for reduced price sale and reduced lead time.



Number of orders qualifying for "discounted price customer" and "less lead time customers" are 2 distributions of discrete random variables.

$E(X1) = \sum x_i p_i$ & $E(X2) = \sum x_2 p_j$

p_i is the i^th^ criteria to qualify for subset X1 and p_j is the j^th^ criteria to qualify for subset X2. There may be any number of criteria and their respective combinations and satisfaction to qualify for any of these two subsets. Depending on that the final probability density function will be derived as given in above equations. Combined expectation of subset X1 and X2 will be the decision making number for selecting the value of ȥ.

$$ȥ = f[E(X1) + E(X2)]$$

ARIMA modelling of Time Series Data for Subset creation:

A set of monthly order data with customer description in one column and number of order enquiry on the other in chronological order can create the required input in the form of Time series of last 10 years on similar category of aircrafts. This data can be readily extracted form the past order books of the OEM. This data set must be created in manner to represent a particular pattern in the time series data. Once the data

set is finalized it needs to be checked for the stationary. If the data is not stationary through its variance it needs to be treated under mathematical transformation to get the form of the table in a stationary manner. Once the data behaves stationary on both mean and variance the integrated item of the model can be made as 1.

ACF and PACF plots can be made to derive the AR and MA component of the model. We cannot expect any seasonal component present in the residual as sale of aircraft is not seasonally guided.

This result eventually will lead to expectations of buyers entering into subset X1 and X2 as a percentage of total number of buyers present into the market. But since the buying pattern of aircrafts are changing rapidly in last 5 years where the potential market is shifting from Airline companies to lessors and investors as financial asset, a data set with a bigger span more than 5 years can mislead the conclusion. Utmost care need to be taken on creating the secondary data set for the ARIMA modelling.

3. INCREMENTAL BOUNDARY PROFIT CALCULATION

Once the subsets are created, a reasonable quantity of capacity allotment needs to be done on those segments. A second DSCR model will be applied on the expected qualified orders of subset DPC (Discounted Priced customers) and subset LLC (Less Lead Time customers) to filter only highest profit orders. Number of entrants in the subset DPC is $E_{DPC}(Xi)$ and in LLC is $E_{LLC}(Xi)$. Order taken through DSCR inside subset DPC is $P_{DPCj}(Xk)$ times of $E_{DPC}(Xi)$ where $0< P_{DPCj}(Xk)<1$ and similarly for LLC its $P_{LLCj}(Xk)$ times $E_{LLC}(Xi)$ where $0< P_{LLCj}(Xk)<1$. Remaining set of buyers with market paralyzing business interest are lying in a subset Ʉ with c- $E_{DPC}(Xi)$ $P_{DPCj}(Xk)$- $E_{LLC}(Xi)$ $P_{LLCj}(Xk)$ quantity. Hence, in reality, the total capacity created from operation cannot be distributed entirely in subset Ʉ. Initially defined DSCR system should operate with in house capacity of $C = c- E_{DPC}(Xi) P_{DPCj}(Xk)- E_{LLC}(Xi) P_{LLCj}(Xk)$ and not only c. This will results the discussed profit margin of Z = (Ƶ + ƶ) for non-privileged customer segment.

$E_{DPC}(Xi)$ and $E_{LLC}(Xi)$ are binomially derived calculated figures from the past data. So it's a given quantity for the calculation. Quantity which is driven by strategic business mind as par the future business is $P_{DPCj}(Xk)$ and $P_{LLCj}(Xk)$.

The next step is going to be analysing the ratio of number of order filtered through DSCR stage 1 with total number of orders enquired. Let's say the given ratio is

$$\beta_{filterDSCR} = \frac{Number\ of\ orders\ came\ through\ DSCR\ filter}{Total\ number\ of\ order\ enquiry} = \frac{c - \mathrm{E_{DPC}(Xi)P_{DPCj}(Xk)} - \mathrm{E_{LLC}(Xi)P_{LLCj}(Xk)}}{Q_{enqNP}}$$

Q_{enqNP} = Number of order enquiry arrived form non-privileged customer segment.

This ratio will guide the strategic decision making part from the higher management of the organisation to ensure better shape of future market in Aerospace and can lead to a healthy competitive scenario inside the A&D domain on coming years. For better health of the future market it is always expected that $Ratio_{filterDSCR} < [(Ratio_{filterX1})\ \&\ (Ratio_{filterX2})]$.

$$Ratio_{filterX1} = \frac{Number\ of\ orders\ came\ through\ X1\ DSCR\ Qualification}{Total\ number\ of\ order\ enquiry\ in\ X1\ category} = \frac{E(X1)P(X1)}{Q_{enqX1}}$$

$$Ratio_{filterX2} = \frac{Number\ of\ orders\ came\ through\ X2\ DSCR\ Qualification}{Total\ number\ of\ order\ enquiry\ in\ X2\ category} = \frac{E(X2)P(X2)}{Q_{enqX2}}$$

Q_{enqX1} = Number of order enquiry arrived form DPC customer segment.

Q_{enqX2} = Number of order enquiry arrived form LLC customer segment.

The purpose of the potential business encouragement from OEM point of view will be solved only when $Ratio_{filterDSCR} < Ratio_{filterX1}$ & $Ratio_{filterX2.}$ The correct ratios can be derived once the strategic team of the organization defines its future targets and motives. The values of P(X1) and P(X2) will be decided such that the strategic sale of aircrafts can be satisfied at highest possible overall profit margin for the Aircraft manufacturer.

This will finally result a defined current available capacity in the segments X1 and X2. Now DSCR will be applied respectively to each segment to calculate the profit margin of each segment $ƶ_{X1}$ and $ƶ_{X2}$ which will satisfy the condition Pa = Pr in probability density function curve.

Impact of X2 segmentation on overall delivery schedule:

X2 segmentation is meant to disturb the overall delivery schedule of the final aircrafts as it commits less lead time delivery to the potential buyers depending on their necessity and sustainability of business model. This commitment automatically leads to optimization of scheduled deliveries of other aircrafts not belonging to X2 category. Hence depending on the size of X2 subset it is mandatory to reiterate the delivery commitment to the buyers to avoid failing to meet the completion deadline of the proposed model.

4. NUMERICAL RESULTS AND ANALYSIS

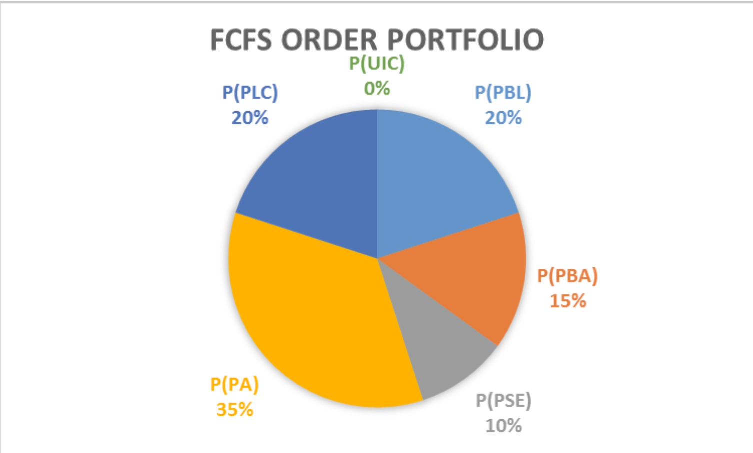
In this section we will try to simulate the experimental input as a real case business scenario by comparing 3 models namely FCFS (First come first serve basis), Generalised DSCR and Incremental boundary profit DSCR. Finally the intent is to show the financial and strategic benefits of the later over the priors.

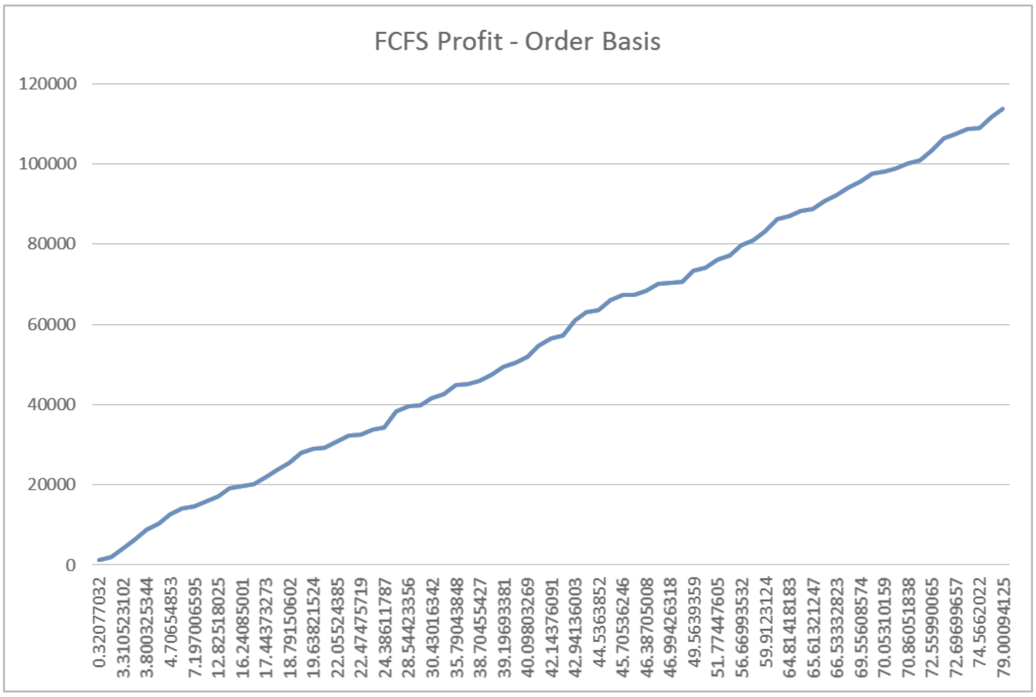
The case is designed for total order enquiry of E_q=14,021 with a maximum designed initial capacity limit of c=9000 with a production demand ratio of β_{pd}=9,000/14,021=0.642.

FCFS:

Under this model organization is designed to take all the orders coming in line one after another till the complete stock gets exhausted.

Results from numerical simulations are as presented below.





Single Class DSCR:

This process is applied on the whole sample treating as a single set. A generalised DSCR is applied as described in last section.

6 cases of probability design E(Xi) *Refer [INCREMENTAL BOUNDARY PROFIT CALCULATION* is proposed for 6 customer classes as a six by six matrix. These customer classes are as follows:

Ordering Business type
probability of private big leasing company E(X1)
Pobability of private big Airline E(X2)
Probability of small Airline and leasing Ent E(X3)
Probability of Public Airline E(X4)
Probability of Public Leasing company E(X5)
Probability of un-identified customers E(X6)

[Please refer APPENDIX] for detailed probability design.

A random number is generated to capture capacity requirement of orders from a Normal distribution with mean μq and standard deviation σq. Let T be the length of the planning horizon, and C0 be the initial capacity at the start of the order arrival process. The given parameters include the following: μq = 110, σq = 45, T = 120 months (10 years), and C0 = 9000. Boundary profit margin is decided from the

pricing demand curve to exhaust complete capacity at the end of cycle. The boundary profit margin is set at z=9.13% for simulation set 1. [Please refer APPENDIX] for detailed calculation.

Capacity tightness (γ) is defined by the ratio of the total initial available capacity C_0 to the total expected capacity requirements of all orders. Let Xk be the capacity requirement of class k and λ be the total arrival rate, that is, $\lambda = \lambda_1 + \lambda_2 + \lambda_3 + \ldots + \lambda_k$. Hence, if C_0, T, μ_q and γ are given, the capacity tightness is computed by $\gamma = C_0 / \sum_{k=1}^{n} E(X_k)$.

Since $\sum_{k=1}^{n} E(X_k) = \lambda T \mu_q$ and $\gamma = C_0 / \lambda T \mu_q$.

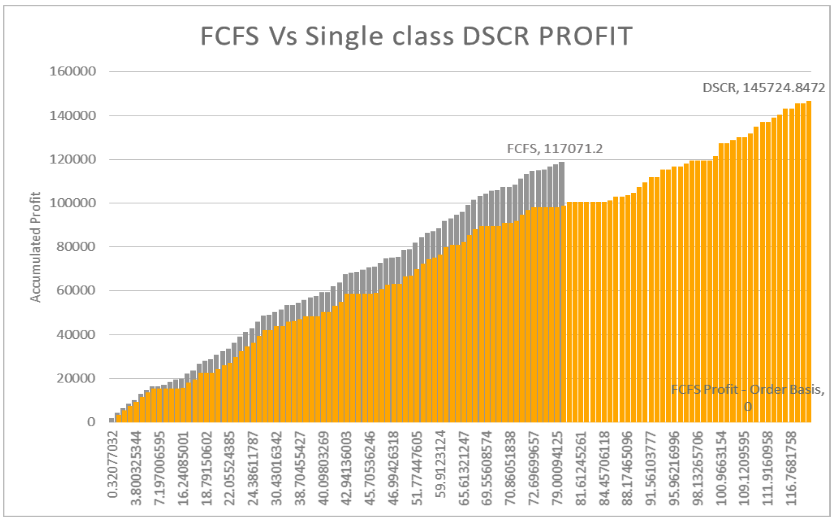
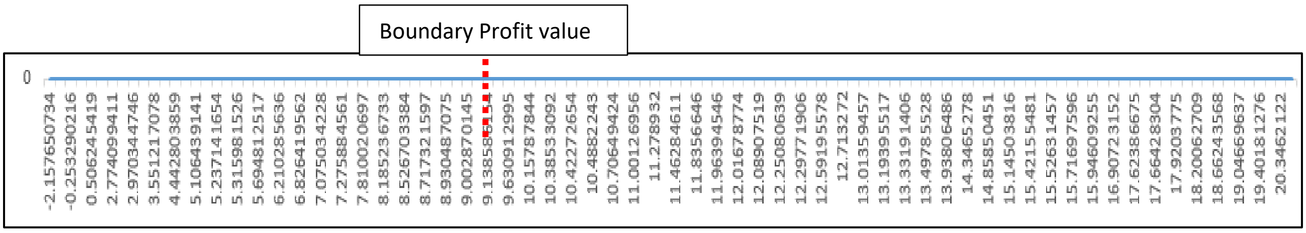
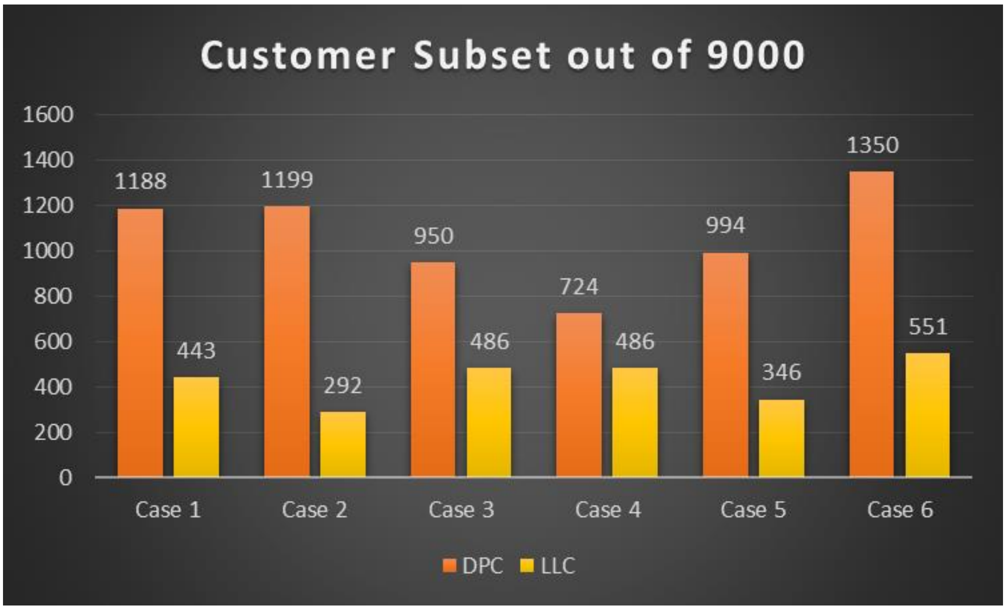


Figure 1: Profit Comparison - FCFS Vs Single Class DSCRl



Profit class DSCR:

Three profit classes are simulated as discussed before – non-privileged customers, discounted price customers, and less lead time customers. 6 cases of privilege weightage Pj(Xk) is designed for testing. [Please refer APPENDIX] for detailed weightage. Each probability factor on multiplication with weightage E(Xi).Pj(Xk) *Refer [INCREMENTAL BOUNDARY PROFIT CALCULATION]* will give us the designed factor of total orders that need are belonging from each subset. The cases where privilege weight is given as zero are considered as non-privileged subset and will be exposed to high profit margin cut-off for the orders. The final results gives a subset of discounted price customer (DPC) and less lead-time customers (LLC) for six respective subsets as follows out of total set of 9000 customers.



In the simulated business model big leasing companies and unidentified customer subset are given zero weight (which can change depending on the decision of strategy board of the organization) hence resulting into a non-privileged category.

Subset ratio of non-privileged customers will be given as:

$$\beta_{NP} = \frac{E(X1) + E(X6)}{1} = E(X1) + E(X6)$$

This ratio have taken values as 0.2 and 0.4 in all 6 cases respectively. Hence in a subset capacity allotment of $(c \times \beta_{NP})$ all the 6 classes of business will compete each other where the final orders taken for case 1 subset 1 will be:

$$\beta_{filterDSCR} = \frac{c - \mathrm{E_{DPC}(Xi)P_{DPCj}(Xk)} - \mathrm{E_{LLC}(Xi)P_{LLCj}(Xk)}}{Q_{enqNP}}$$

Now beta for each segment must be calculated from the same factor. This ratio is calculated for an example for case 1.

$$\beta_{filterPBL} = \frac{\mathrm{E}_{\mathrm{DPC}_{PBL}}(\mathrm{Xi})\mathrm{P}_{\mathrm{DPCj}_{PBL}}(\mathrm{Xk})}{\mathrm{E}_{\mathrm{DPC}_{PBL}}(\mathrm{Xi})} = \mathrm{P}_{\mathrm{DPCj}_{PBL}}(\mathrm{Xk}) = 0.04$$

Similarly it should be calculated for the remaining segments or classes of the customers.

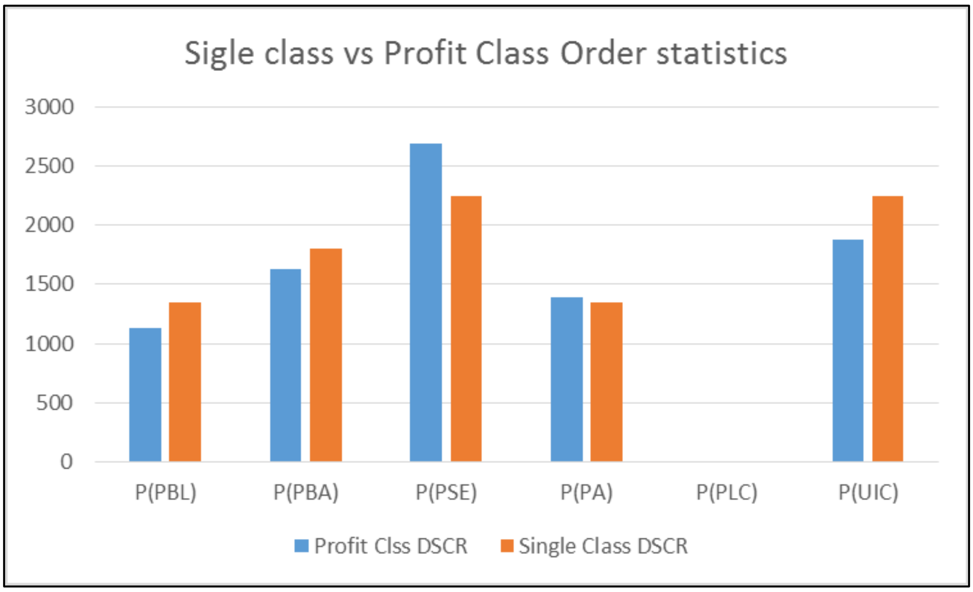
For case 2 the subset of DPC is having entry of 1199 orders and LLC is having 292 [please refer APPENDIX]. So the remaining non-privileged category is having a set of order of 9000-1199-292=7509 order entries.

Total participating orders in general category = P(Class X).Q_{enqNP} (A) = P(Class X).14021

Pool from Non-privileged sell of this class = P(Class X).Order of this class from non-privileged sell (B) = P(Class X).7509

Participating orders in privileged category = (A)-(B)

Classes	Case 2	Total Perticipating Orders	Pool from Non-privileged sell	Perticipating Orders in privileged category
P(PBL)	0.15	2103	1126.44	977
P(PBA)	0.2	2804	1501.92	1302
P(PSE)	0.25	3505	1877.4	1628
P(PA)	0.15	2103	1126.44	977
P(PLC)	0	0	0	0
P(UIC)	0.25	3505	1877.4	1628



Above picture shows for case 2 in profit class DSCR it takes out shares of orders of non-privileged customers to add in privileged category to exploit the market power of the OEM towards a better market balance for tomorrows business scenario.

In the overall profit of the organization there will be a local negative impact of Profit class DSCR approach over Single class DSCR approach because of the privileged segment pool of DPC as LLC won't have any impact on the profit but on delivery schedule of other classes.

Hence the accumulated profit at the end of the time horizon T will lie somewhere in between FCFS model and single class DSCR model.

5. CONCLUSION

Single class DSCR is showing a clear advantage of accumulated profit for the aircraft manufacturer over first come first serve basis. This tool also exhausts the complete ordering cycle at its edge to exploit the market for optimum order book entry and maxim profit margin. Even though the profit class DSCR approach shown a decrement in accumulated profit value for the seller, it definitely serves the next very important issue of today's aerospace imbalanced buyers' market where OEMs are losing the negotiation power under powerful buying portfolio of highly funded lessors at todays imbalanced market. Hence to retain the market power to seller that is OEMs it's a strategic ambition to sacrifice a dedicated percentage of profit towards retaining a sustainability of the manufacturers rather than completely depending on after sales market of Aircrafts which is the upcoming scenario if not corrected.

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My sincere thanks also goes to all the professors from both Toulouse Business School and IIM Bangalore who taught us with their immense commitment towards channelizing out strategic thinking ability day by day for betterment of future of mankind.

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APPENDIX 1

Month Timeline of Orders	Random No.	profit margin of orders (Norm Dist)	Probability of gettiing more profitable order	Alpha Value	Theta Value	capacity of more profitable orders	Order Decision
1	0.237728	7.075034228	93	0.78	93	10865.9	ORDER REJECTED
2	0.789278	15.42155481	25	0.21	25	2920.9	ORDER TAKEN
3	0.728559	14.3465278	31	0.26	31	3622.0	ORDER TAKEN
4	0.533533	11.46284611	59	0.49	59	6893.4	ORDER TAKEN
5	0.520635	11.28460486	60	0.50	60	7010.3	ORDER TAKEN
6	0.885955	17.62912556	14	0.12	14	1635.7	ORDER TAKEN
7	0.887184	17.66428304	13	0.11	13	1518.9	ORDER TAKEN
8	0.382696	9.358753165	76	0.63	76	8879.7	ORDER TAKEN
9	0.070099	2.887221766	112	0.93	112	13085.8	ORDER REJECTED
10	0.243228	7.172233828	92	0.77	92	10749.1	ORDER REJECTED
11	0.332423	8.617217529	84	0.70	84	9814.4	ORDER REJECTED
12	0.294696	8.031553141	88	0.73	88	10281.7	ORDER REJECTED
13	0.367516	9.138586154	77	0.64	77	8996.5	ORDER TAKEN
14	0.904627	18.19606709	10	0.08	10	1168.4	ORDER TAKEN
15	0.804452	15.71697596	21	0.18	21	2453.6	ORDER TAKEN
16	0.775999	15.17312828	26	0.22	26	3037.8	ORDER TAKEN
17	0.35826	9.002870145	79	0.66	79	9230.2	ORDER REJECTED
18	0.156352	5.447398518	100	0.83	100	11683.8	ORDER REJECTED
19	0.858598	16.90723152	17	0.14	17	1986.2	ORDER TAKEN
20	0.758519	14.85850451	29	0.24	29	3388.3	ORDER TAKEN
21	0.458261	10.42350876	68	0.57	68	7945.0	ORDER TAKEN
22	0.815751	15.94609255	19	0.16	19	2219.9	ORDER TAKEN
23	0.935149	19.33402217	4	0.03	4	467.4	ORDER TAKEN
24	0.500003	11.00004481	64	0.53	64	7477.6	ORDER TAKEN
25	0.702499	13.92380984	34	0.28	34	3972.5	ORDER TAKEN
26	0.664211	13.33191406	37	0.31	37	4323.0	ORDER TAKEN
27	0.895849	17.9203775	11	0.09	11	1285.2	ORDER TAKEN
28	0.339059	8.717321597	83	0.69	83	9697.5	ORDER REJECTED
29	0.456913	10.40481814	70	0.58	70	8178.6	ORDER TAKEN
30	0.349299	8.870330978	82	0.68	82	9580.7	ORDER REJECTED
31	0.808832	15.80479531	20	0.17	20	2336.8	ORDER TAKEN
32	0.655017	13.19395517	39	0.33	39	4556.7	ORDER TAKEN
33	0.791856	15.4708215	24	0.20	24	2804.1	ORDER TAKEN
34	0.563023	11.87250677	56	0.47	56	6542.9	ORDER TAKEN
35	0.14388	5.153242346	104	0.87	104	12151.1	ORDER REJECTED
36	0.356481	8.976655578	80	0.67	80	9347.0	ORDER REJECTED
37	0.8954	17.90671807	12	0.10	12	1402.1	ORDER TAKEN
38	0.010144	-1.765418693	118	0.98	118	13786.9	ORDER REJECTED
39	0.581617	12.13317091	50	0.42	50	5841.9	ORDER TAKEN
40	0.669029	13.40478091	36	0.30	36	4206.2	ORDER TAKEN
41	0.93847	19.48130102	2	0.02	2	233.7	ORDER TAKEN
42	0.280959	7.810020697	89	0.74	89	10398.6	ORDER REJECTED
43	0.150695	5.315981526	101	0.84	101	11800.6	ORDER REJECTED
44	0.235604	7.037173761	94	0.78	94	10982.7	ORDER REJECTED
45	0.204115	6.451439169	96	0.80	96	11216.4	ORDER REJECTED
46	0.428343	10.00672568	74	0.62	74	8646.0	ORDER TAKEN
47	0.714362	14.11394739	32	0.27	32	3738.8	ORDER TAKEN
48	0.520224	11.278932	61	0.51	61	7127.1	ORDER TAKEN
49	0.764814	14.97030319	28	0.23	28	3271.5	ORDER TAKEN
50	0.439155	10.15787844	73	0.61	73	8529.2	ORDER TAKEN
51	0.918557	18.67486404	6	0.05	6	701.0	ORDER TAKEN
52	0.593264	12.29771906	47	0.39	47	5491.4	ORDER TAKEN
53	0.936694	19.40181276	3	0.03	3	350.5	ORDER TAKEN
54	0.95537	20.3462122	1	0.01	1	116.8	ORDER TAKEN
55	0.569563	11.96394546	55	0.46	55	6426.1	ORDER TAKEN
56	0.589951	12.25080639	49	0.41	49	5725.0	ORDER TAKEN
57	0.455508	10.38533092	71	0.59	71	8295.5	ORDER TAKEN
58	0.913642	18.49940724	8	0.07	8	934.7	ORDER TAKEN
59	0.401709	9.630912995	75	0.63	75	8762.8	ORDER TAKEN
60	0.167378	5.694812517	99	0.83	99	11566.9	ORDER REJECTED

Month Timeline of Orders	Random No.	profit margin of orders (Norm Dist)	Probability of gettiing more profitable order	Alpha Value	Theta Value	capacity of more profitable orders	Order Decision
61	0.59012	12.25319096	48	0.40	48	5608.2	ORDER TAKEN
62	0.918216	18.66243568	7	0.06	7	817.9	ORDER TAKEN
63	0.928271	19.04669637	5	0.04	5	584.2	ORDER TAKEN
64	0.675142	13.49785528	35	0.29	35	4089.3	ORDER TAKEN
65	0.223976	6.826419562	95	0.79	95	11099.6	ORDER REJECTED
66	0.353356	8.930487075	81	0.68	81	9463.9	ORDER REJECTED
67	0.304404	8.185236733	87	0.73	87	10164.9	ORDER REJECTED
68	0.478721	10.70649424	65	0.54	65	7594.5	ORDER TAKEN
69	0.067377	2.774099411	113	0.94	113	13202.7	ORDER REJECTED
70	0.574626	12.03489667	52	0.43	52	6075.6	ORDER TAKEN
71	0.54881	11.67461024	58	0.48	58	6776.6	ORDER TAKEN
72	0.614039	12.59423871	44	0.37	44	5140.9	ORDER TAKEN
73	0.471006	10.59992631	66	0.55	66	7711.3	ORDER TAKEN
74	0.120577	4.553423023	106	0.88	106	12384.8	ORDER REJECTED
75	0.059671	2.433543663	114	0.95	114	13319.5	ORDER REJECTED
76	0.326467	8.526703384	85	0.71	85	9931.2	ORDER REJECTED
77	0.309064	8.258220234	86	0.72	86	10048.0	ORDER REJECTED
78	0.637539	12.93537992	42	0.35	42	4907.2	ORDER TAKEN
79	0.452201	10.33943608	72	0.60	72	8412.3	ORDER TAKEN
80	0.028198	0.506245419	115	0.96	115	13436.3	ORDER REJECTED
81	0.260153	7.464186183	90	0.75	90	10515.4	ORDER REJECTED
82	0.116588	4.442803859	107	0.89	107	12501.6	ORDER REJECTED
83	0.115487	4.411810675	108	0.90	108	12618.5	ORDER REJECTED
84	0.020376	-0.253290216	117	0.98	117	13670.0	ORDER REJECTED
85	0.147633	5.243481615	102	0.85	102	11917.4	ORDER REJECTED
86	0.500092	11.00126956	63	0.53	63	7360.8	ORDER TAKEN
87	0.622291	12.713272	43	0.36	43	5024.0	ORDER TAKEN
88	0.147367	5.237141654	103	0.86	103	12034.3	ORDER REJECTED
89	0.578483	12.08907519	51	0.43	51	5958.7	ORDER TAKEN
90	0.516045	11.22125663	62	0.52	62	7243.9	ORDER TAKEN
91	0.816642	15.96453563	18	0.15	18	2103.1	ORDER TAKEN
92	0.602621	12.43075044	46	0.38	46	5374.5	ORDER TAKEN
93	0.560382	11.8356646	57	0.48	57	6659.8	ORDER TAKEN
94	0.008372	-2.157650734	119	0.99	119	13903.7	ORDER REJECTED
95	0.904768	18.20062709	9	0.08	9	1051.5	ORDER TAKEN
96	0.072154	2.970344746	111	0.93	111	12969.0	ORDER REJECTED
97	0.794736	15.52631457	23	0.19	23	2687.3	ORDER TAKEN
98	0.087816	3.551217078	109	0.91	109	12735.3	ORDER REJECTED
99	0.458204	10.42272654	69	0.58	69	8061.8	ORDER TAKEN
100	0.573335	12.01678774	53	0.44	53	6192.4	ORDER TAKEN
101	0.082547	3.365206758	110	0.92	110	12852.1	ORDER REJECTED
102	0.191916	6.210285636	97	0.81	97	11333.3	ORDER REJECTED
103	0.14196	5.106439141	105	0.88	105	12268.0	ORDER REJECTED
104	0.642858	13.01359457	41	0.34	41	4790.3	ORDER TAKEN
105	0.987933	23.40242515	0	0.00	0	0.0	ORDER TAKEN
106	0.022992	0.024480855	116	0.97	116	13553.2	ORDER REJECTED
107	0.571887	11.99649215	54	0.45	54	6309.2	ORDER TAKEN
108	0.462932	10.4882243	67	0.56	67	7828.1	ORDER TAKEN
109	0.753272	14.76652249	30	0.25	30	3505.1	ORDER TAKEN
110	0.885771	17.62386675	15	0.13	15	1752.6	ORDER TAKEN
111	0.801208	15.65268495	22	0.18	22	2570.4	ORDER TAKEN
112	0.61388	12.59195578	45	0.38	45	5257.7	ORDER TAKEN
113	0.188013	6.13116321	98	0.82	98	11450.1	ORDER REJECTED
114	0.703396	13.93806486	33	0.28	33	3855.6	ORDER TAKEN
115	0.644698	13.04074663	40	0.33	40	4673.5	ORDER TAKEN
116	0.774468	15.14503816	27	0.23	27	3154.6	ORDER TAKEN
117	0.249167	7.275884561	91	0.76	91	10632.2	ORDER REJECTED
118	0.658962	13.25296906	38	0.32	38	4439.8	ORDER TAKEN
119	0.364044	9.08780913	78	0.65	78	9113.3	ORDER REJECTED
120	0.878345	17.41715669	16	0.13	16	1869.4	ORDER TAKEN

Figure 2: Single Class DSCR Order Decisions

Sr. No	Month Timeline of Orders	Random no	Capacity Requirement of orders	Total Req
1	0.3	0.759926	141.7729399	141.7729
2	0.5	0.756371	141.260389	283.0333
3	3.3	0.729705	137.5364872	420.5698
4	3.6	0.864171	159.4663153	580.0361
5	3.8	0.7661	142.6728965	722.709
6	3.9	0.690732	132.4067375	855.1158
7	4.7	0.377762	95.98857465	951.1043
8	7.1	0.91325	171.246926	1122.351
9	7.2	0.054146	37.73389883	1160.085
10	7.4	0.271703	82.65488533	1242.74
11	12.8	0.782168	145.0790493	1387.819
12	13.2	0.454981	104.9110626	1492.73
13	16.2	0.055368	38.22985449	1530.96
14	16.8	0.523953	112.7034835	1643.664
15	17.4	0.337682	91.15411313	1734.818
16	18.1	0.91641	172.1594369	1906.977
17	18.8	0.723656	136.7182069	2043.695
18	19.4	0.836029	154.0221121	2197.717
19	19.6	0.49571	109.5161162	2307.233
20	21.5	0.354989	93.2651096	2400.499
21	22.1	0.448747	104.2027434	2504.701
22	22.4	0.77913	144.6166497	2649.318
23	22.5	0.754084	140.9328853	2790.251
24	23.7	0.882861	163.5234845	2953.774
25	24.4	0.424158	101.3929564	3055.167
26	28.2	0.993248	221.1579923	3276.325
27	28.5	0.770546	143.3291123	3419.654
28	30.1	0.027671	23.77211131	3443.427
29	30.4	0.708932	134.7620211	3578.189
30	33.3	0.261294	81.22868834	3659.417
31	35.8	0.637734	125.8583936	3785.276
32	37.0	0.012317	8.881165985	3794.157
33	38.7	0.09908	52.09348118	3846.25
34	38.9	0.458064	105.2609007	3951.511
35	39.2	0.88968	165.1173141	4116.628
36	39.9	0.270094	82.43624763	4199.065
37	40.1	0.360317	93.90746223	4292.972
38	41.1	0.576746	118.7109669	4411.683
39	42.1	0.989094	213.2136706	4624.897
40	42.3	0.530064	113.39441	4738.291
41	42.9	0.930567	176.6011369	4914.892
42	43.7	0.305421	87.10077895	5001.993
43	44.5	0.146754	62.72933514	5064.723
44	45.1	0.660296	128.5972303	5193.32
45	45.7	0.722921	136.6193215	5329.939
46	45.8	0.036537	29.34317442	5359.282
47	46.4	0.471734	106.8090112	5466.091
48	46.4	0.923098	174.1799584	5640.271
49	47.0	0.023456	20.58049312	5660.852
50	47.5	0.020889	18.39218058	5679.244
51	49.6	0.828121	152.6045261	5831.848
52	50.1	0.062804	41.07565562	5872.924
53	51.8	0.756262	141.2448065	6014.169
54	56.5	0.50357	110.4026725	6124.572
55	56.7	0.77563	144.0882409	6268.66
56	57.1	0.144817	62.3484372	6331.008
57	59.9	0.66001	128.5621138	6459.57
58	62.0	0.856362	157.8852038	6617.456
59	64.8	0.578336	118.8937349	6736.349
60	65.0	0.997436	235.9493433	6972.299

Sr. No	Month Timeline of Orders	Random no	Capacity Requirement of orders	Total Req
61	65.6	0.42845	101.8854995	7074.184
62	66.2	0.82165	151.4752967	7225.659
63	66.5	0.584735	119.6309614	7345.29
64	68.8	0.493527	109.2697962	7454.56
65	69.6	0.863193	159.2650868	7613.825
66	69.7	0.681148	131.1910596	7745.016
67	70.1	0.031205	26.14826953	7771.165
68	70.8	0.503787	110.4271193	7881.592
69	70.9	0.441651	103.3947416	7984.986
70	72.0	0.14078	61.54295975	8046.529
71	72.6	0.993184	221.0074956	8267.537
72	72.6	0.837782	154.3421996	8421.879
73	72.7	0.471569	106.7902657	8528.669
74	74.4	0.205573	73.01551875	8601.685
75	74.6	0.713703	135.3905314	8737.075
76	75.1	0.881887	163.301257	8900.377
77	79.0	0.440964	103.316359	9000.693
78	79.4	0.139088	61.20076775	9064.894
79	80.4	0.770756	143.3602641	9208.254
80	81.0	0.391599	97.61804276	9305.872
81	81.6	0.881552	163.2251864	9469.097
82	82.1	0.719358	136.1420403	9605.239
83	82.1	0.274055	82.97328611	9688.213
84	83.7	0.981933	204.2936301	9892.506
85	84.5	0.111581	55.182617	9947.689
86	84.5	0.117457	56.54931789	10004.24
87	85.9	0.649529	127.2821537	10131.52
88	87.5	0.982497	204.873004	10336.39
89	88.2	0.057258	38.98018598	10375.37
90	88.2	0.322713	89.29432256	10464.67
91	89.1	0.854346	157.4866342	10622.15
92	90.2	0.777608	144.3863574	10766.54
93	91.6	0.978663	201.2101705	10967.75
94	91.6	0.515308	111.7271139	11079.48
95	94.3	0.866704	159.9925959	11239.47
96	95.1	0.051191	36.49639854	11275.97
97	96.0	0.389284	97.346646	11373.31
98	96.7	0.480519	107.8017406	11481.12
99	96.8	0.461948	105.7013006	11586.82
100	98.1	0.52164	112.4422017	11699.26
101	98.1	0.687589	132.0062492	11831.27
102	98.9	0.192352	70.8832308	11902.15
103	99.6	0.571025	118.0543033	12020.2
104	100.7	0.785652	145.6141201	12165.82
105	101.0	0.992064	218.5330464	12384.35
106	103.9	0.069777	43.51453689	12427.86
107	104.3	0.633774	125.3839745	12553.25
108	107.5	0.578905	118.9591483	12672.21
109	109.1	0.002461	-16.5448479	12655.66
110	110.4	0.398886	98.46963121	12754.13
111	110.5	0.911136	170.6503868	12924.78
112	111.9	0.824587	151.9845547	13076.77
113	111.9	0.328746	90.04802745	13166.82
114	112.2	0.704841	134.2269266	13301.04
115	114.2	0.436066	102.7571524	13403.8
116	116.7	0.88457	163.9166099	13567.72
117	116.8	0.922959	174.1368431	13741.85
118	117.1	0.8176	150.7815462	13892.63
119	119.4	0.206448	73.15365953	13965.79
120	120.1	0.109718	54.73873134	14020.53

The capacity requirement of orders is a random number that is generated from a Normal distribution with mean μq and standard deviation σq	
μq	110
σq	45

Figure 3: Detail of capacity requirement and timeline of orders

		FORECAST					
Ordering Business type	Classes	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
probability of private big leasing company E(X1)	P(PBL)	0.2	0.15	0.1	0.35	0.2	0
Pobability of private big Airline E(X2)	P(PBA)	0.15	0.2	0.25	0.15	0	0.25
Probability of small Airline and leasing Ent E(X3)	P(PSE)	0.1	0.25	0.2	0	0.15	0.3
Probability of Public Airline E(X4)	P(PA)	0.35	0.15	0	0.2	0.25	0.05
Probability of Public Leasing company E(X5)	P(PLC)	0.2	0	0.15	0.25	0.2	0.2
Probability of un-identified customers E(X6)	P(UIC)	0	0.25	0.3	0.05	0.2	0.2

Figure 4: Different Business Case forecasts of customer classifications

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Scale of 1	0	0	0	0	0	0
	0.04	0.06	0.08	0.1	0.12	0.14
	0.32	0.3	0.28	0.26	0.24	0.22
	0.16	0.16	0.16	0.16	0.16	0.16
	0.08	0.08	0.08	0.08	0.08	0.08
	0	0	0	0	0	0

Figure 5: Class DPC Weight of Privilege

Scale of 1	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
	0	0	0	0	0	0
	0.16	0.2	0.24	0.24	0.22	0.24
	0.04	0.02	0	0	0.08	0
	0.04	0.06	0.04	0.12	0.08	0.04
	0.2	0.18	0.2	0.12	0.16	0.2
	0	0	0	0	0	0

Figure 6: Class LLC Weight of Privilege

Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
0	0	0	0	0	0
64.8	129.6	216	162	0	378
345.6	810	604.8	0	388.8	712.8
604.8	259.2	0	345.6	432	86.4
172.8	0	129.6	216	172.8	172.8
0	0	0	0	0	0
1188	1198.8	950.4	723.6	993.6	1350

Figure 7: No of order entries in DPC out of total set 9000

Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
0	0	0	0	0	0
129.6	216	324	194.4	0	324
21.6	27	0	0	64.8	0
75.6	48.6	0	129.6	108	10.8
216	0	162	162	172.8	216
0	0	0	0	0	0
442.8	291.6	486	486	345.6	550.8

Figure 8: No of order entries in LLC out of total set 9000

Author's Profile:

Uttiya Mukherjee, an Aeronautical Engineer by profession having a technical industry background of 7 years in design and development of commercial aircrafts. He has excelled in his career in every stage and withstand all the professional challenges encountered being as dynamic as the industry of Aerospace and Aviation. Being a strategic thinker future of Aircraft sellers business approaches always made him to put on design board again and again. Hence most of the articles published in soft forums like LinkedIn etc talks about various future approachable point of views of the driving business of OEMs.