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CUSTOMER RELATIONSHIP MANAGEMENT AND LOGISTICS MANAGEMENT IN THE RAILWAY AND AIRLINE RESERVATION SYSTEMS

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INTRODUCTION & ASSUMPTIONS

What is the type of information keyed in or maintained in a repository when a Customer books his/her ticket(s) e.g. For a train it will be – 1) Train Name & Number 2) Class of seat - II class, First class, 3-tier AC etc. 3) Station boarding at 4) Station from and to 5) Name of Passengers, their age, sex and preference of birth (Upper, Lower, Middle etc.) 6) Date of Journey 7) Name, Address and telephone number of person booking the ticket (Our humble Indian Reservation form which we have filled up on several occasions). Similar kind of information is filled up and maintained by Airlines of passengers travelling by the Air. Both of these repositories give a set of rich information for both CRM purposes and Logistics. Please note the Customer is the key stake holder (hence CRM comes into play) and the system is for providing Travel services (hence Logistics comes in the picture).

Let us assume that locations are fixed by Development agencies based on considerations of Refuelling, Maintenance and Importance of Location e.g. Airport/Station at location X1, X2 etc. and Terminal Airports/Stations at location Y1B, Y1E for Route R1, Y2B, Y2E for Route R2 etc. and the Routes/Paths R1, R2 etc. are rarely varying. The key information that can be extracted from a Reservation system with respect to CRM and Logistics is – No. of passengers travelling daily/weekly/ monthly/yearly (on an average) between different locations on a particular route (say between locations Xi and Xj along route Rn). Route is equivalent to a Train or Flight between two terminals Yk and Yl.

There are some similarities and dissimilarities between the Railway and Airline Reservation Systems which we shall brief take note of and bear at the back of our mind for our discussion/analysis, namely –

- Both are typically long distance carriers
- Railways is a low cost mass transport system designed for the common man whereas Airlines is a high cost transport system designed for the privileged few
- Both are high capital and high development costs but Railways has low maintenance/operations costs compared to high maintenance/operations costs for Airlines
- In both the cases the costs of Recovery is low and long-term
- Trains have higher passenger bearing capacity whereas Aircrafts have low passenger bearing capacity
- The number of intermediate stops in Railways is more compared to that in Airlines

Due to above peculiarities of Railway and Airline systems, the passenger ticket costs in Railways is low compared to that of Airlines. This results in higher passenger traffic typically in Railways as compared to that in Airlines. Hence normally a Quota based Reservation Systems has to be enforced in the Railways whereas Promotional/Marketing strategies are typically employed in Airline Systems to drive passenger traffic.
Now, taking the help of suitable examples in the Railway System we shall explain Reservation systems in general and the special problems in Railway Reservation Systems; also with the help of suitable examples in the Airline System we shall examine special problems in the Airline Reservation Systems.

Railway Reservation System

Reservation Quotas and Reservation scenarios

Suppose 100 passengers travel per week from Bombay to Howrah by Bombay-Howrah Mail train running twice a week (Tue and Thurs), 1 train assume has capacity of 50 passengers each and there are 3 intermediate stops (Akola, Nagpur and Tatanagar) between the Terminal stations, Bombay and Howrah on the Bombay-Howrah Mail route. Please note the example is drawn to a smaller scale but method can be worked out on larger scales and with finer granularity.

Let us assume that the average mean distribution of passengers between stations for Tues is as shown in Table 1 -

Table 1.

To	**Bbay**	**Akola**	**Nagpur**	**TataNagar**	**Hwh**	**Total**
From						
Bombay	0	1	3	1	10	**15**
Akola	0	0	5	4	6	**15**
Nagpur	0	0	0	6	4	**10**
Tatanagar	0	0	0	0	10	**10**
Hwh	0	0	0	0	0	**0**
Total	0	1	8	11	30	50

Row totals represent no of passengers boarding from a particular station.

Column totals represent no of passengers alighting at a particular station.

Let us assume for above train that there are only II tier sleeper and 3-tier AC sleeper classes and each coach of II tier can accommodate 5 passengers; and each coach of 3-tier AC can accommodate 5 passengers each. And let us assume that the average means distribution of II tier and 3-tier berths are as shown in Table 2 –

Table 2.

To	Bbay		Akola		Nagpur		TataNagar		Hwh		Total	
From	II	3-tier	II	3-tier	II	3-tier	II	3-tier	II	3-tier		
Bombay	0	0	1	0	2	1	1	0	5	5	**15**	
Akola	0	0	0	0	5	0	4	0	4	2	**15**	
Nagpur	0	0	0	0	0	0	6	0	3	1	**10**	
Tatanagar	0	0	0	0	0	0	0	0	10	0	**10**	
Hwh	0	0	0	0	0	0	0	0	0	0	**0**	
Sub-Total	0	0	1	0	7	1	11	0	22	8	41	9

Number of 3 -tier berths = 9

Assuming a 5% variance, Total no. of min/max 3-tier berths = 9 (min)/10 (max) approx i.e. 2 coaches approx.

=> Number of coaches = 9/5 = 2 approx.

Number of II tier berths = 41

Assuming a 10% variance, Total no. of min/max II-tier berths = 37 (min)/46 (max) approximately i.e. 8/10 coaches approx.

=> Number of coaches = 41/5 = 9 approx.

And the Railway Manager might add 2 more coaches for undocumented, unrecorded, unreserved coaches.

Hence total number of coaches = 13 approximately but let us assume that the min-max number of coaches the train can pull is 12 to 15 coaches. In which case depending on the policy of the Railways and looking at the data i.e. no. of cancellations/no. on waiting list etc. , the Railway Manager might decide to add/drop coaches from a particularly category e.g. if the Railway Policy might say the min/max values for the different categories is as follows for a particular route–

3-tier: 2

II-tier: 8/10

Unreserved: 2/3

=>The number of coaches can be anywhere from 12 to 15 coaches depending on real-time reservation data.

N.B. For determining average mean distributions of Table A and Table B there are a variety of Forecasting techniques available, for more details see Appendix.

Now let us say for above example the Reserved berths is determined as 2 coaches for 3-tier AC and 9 coaches for II-tier sleeper => there is one vacant 3-tier AC berth and 4 vacant II-tier sleeper berths to be allocated for From/To stations. How do we rationalize to which From/To stations we should allocate the berths. Again this depends on Railway Policy, what are the Objectives of the Railways, to maximize profit or to maximize service or to reduce Recovery costs etc or some product mix of these criteria. If the Policy Rule says that allocate

Fare wise from max to min for 3-tier AC berths (we will need a Fare table for 3-tier AC for this, here motive is maximizing profit from 3-tier AC passengers) and allocate Passenger-wise from max to min for II-tier sleeper berths (for this Table B is sufficient, here motive is maximizing service for II-tier passengers) or alternatively the Policy Rule might say allocate Distance-wise from max to min for II-tier sleeper berths (for this we will need a distance table for all From/To stations, here again the motive maybe maximizing service for long-distance II-tier passengers. N.B. Fares might not be directly proportional to distance, considerations of Fares and the Fare Table might depend on other criteria than just distance). Let us say the Policy says that allocate Fare wise from max to min for 3-tier AC berths and allocate Passenger-wise from max to min for II-tier sleeper berths; and the Fare Table for 3-tier AC berths and Table 4 is as shown below –

Table 3. Fare for 3-tier AC berths

To	**Bbay**		**Akola**		**Nagpur**		**TataNagar**		**Hwh**	
From	**II**	**3-tier**	**II**	**3-tier**	**II**	**3-tier**	**II**	**3-tier**	**II**	**3-tier**
Bombay	-	0	-	3	-	5	-	7	-	10
Akola	-	0	-	0	-	3	-	5	-	7
Nagpur	-	0	-	0	-	0	-	3	-	6
Tatanagar	-	0	-	0	-	0	-	0	-	4
Hwh	-	0	-	0	-	0	-	0	-	0

Table 4.

To	**Bbay**		**Akola**		**Nagpur**		**TataNagar**		**Hwh**		**Total**	
From	**II**	**3-tier**	**II**	**3-tier**	**II**	**3-tier**	**II**	**3-tier**	**II**	**3-tier**		
Bombay	0	0	1	0	2	1	1	0	5	5	**15**	
Akola	0	0	0	0	5	0	4	0	4	2	**15**	
Nagpur	0	0	0	0	0	0	6	0	3	1	**10**	
Tatanagar	0	0	0	0	0	0	0	0	10	0	**10**	
Hwh	0	0	0	0	0	0	0	0	0	0	**0**	
Sub-Total	0	0	1	0	7	1	11	0	22	8	41	9

Now on the basis of the Policy, above tables and above determined/rationalized coaches the newly allocated Quota Table 5' might look something like this –

Table 5.

To	**Bbay**		**Akola**		**Nagpur**		**TataNagar**		**Hwh**		**Total**	
From	**II**	**3-tier**	**II**	**3-tier**	**II**	**3-tier**	**II**	**3-tier**	**II**	**3-tier**		
Bombay	0	0	1	0	2	1	1	0	6	6	**16**	
Akola	0	0	0	0	6	0	4	0	4	2	**15**	
Nagpur	0	0	0	0	0	0	7	0	3	1	**10**	
Tatanagar	0	0	0	0	0	0	0	0	11	0	**10**	
Hwh	0	0	0	0	0	0	0	0	0	0	**0**	
Sub-Total	0	0	1	0	8	1	12	0	24	9	45	10

The one vacant 3-tier AC berth might be allocated to Bombay-Howrah stations as the Fare is max between these two stations. As the max Passenger traffic is between Tatanagar and Howrah, followed by Nagpur and Tatanagar and then by Bombay-Howrah and Akola-Nagpur the 4 vacant II-tier sleeper berths maybe allocated one each between these stations in a descending order or all at once to Tatanagar-Howrah or even proportionately. Assuming the first scheme, the Table B will look as shown above (see Table B'). **Each cell value in Table 5' represents a quota for From/To station respectively.**

Comment -

As the types of berth classes increases the rationalization process becomes increasing difficult e.g. Say if types of berths were II sleeper, 3-tier AC, II-tier AC =>

II sleeper	3-tier	II-tier	
Add/drop	Add/drop	Add/drop	=> 2x2x2 = 8 combinations

And if there are 'n' From/to Stations => 8^n or 8 raised to n permutations/combinations of fares/distances from which the rationalization of berths have to be done.

Further discussion is beyond scope of paper, maybe research can be done on same.

Reservation Scenarios in Real time

Scenario 1 a)

Assume the quota of berths is as shown in Table A (assume each cell is the quota). Assume there are only II tier berths. Now assume passengers are booking tickets as follows -

Passenger P1 books 3 tickets from Bbay to Hwh.

Passenger P2 books 3 tickets from Nagpur to Hwh.

Passenger P3 books 1 ticket from Nagpur to Hwh.

Passenger P4 books 5 tickets from Nagpur to Hwh but Nagpur – Hwh quota is full, hence the ticket is on the waiting list.

Now remaining passenger's book filling up all the quotas except Bbay-Hwh. Passengers P4+i to P4+i+n is on the waiting list.

Then on last day of journey assuming there are no cancellations P4 will get confirmation for his 5 tickets. The remaining 2 berths of Bbay-Hwh quota will be filled up by other passengers in the waiting list in a FIFO or some suitable manner as described below.

Various resource allocation/scheduling mechanisms are possible (reference to Operating Systems by Tanenbaum and any Operations Research book) for resource allocation e.g. It might take passengers in a FIFO manner but quotas in a sequential or round-robin or random manner; the combination of which affect confirmation of seats/berths based on some Operation Research method for maximizing profit/service etc. which is beyond the scope of discussion.

Note : Due to the resource allocation program for allocating berths to waiting list passengers one might often find that a passenger's berth is not confirmed but a person's berth is confirmed with a higher waiting list number due to the nature of allocation program i.e. Allocation does not necessarily take place in FIFO manner, e.g. If a person has waiting list #

1 from Bbay to Hwh and the quota is full but a passenger with waiting list # 2 from Tata nagar to Hwh and the quota being available will get his/her ticket confirmed even though the passenger's waiting list # is 2 (> waiting list # 1).

Scenario 1 b)

Assume the quota of berths is as shown in Table A (assume each cell is the quota). Assume there are only II tier berths. Now passengers are booking tickets as follows -

Passenger P1 books 10 tickets from Bbay to Hwh.

Passenger P2 books 3 tickets from Nagpur to Hwh.

Passenger P3 books 2 tickets from Bbay to Hwh but Bbay-Hwh quota is full => P3 is on the waiting list.

Now remaining passengers book filling up all the quotas except Nagpur-Hwh quota. Passengers P4+i to P4+i+n is on the waiting list.

Then on last day of journey assuming there are no cancellations Railways WILL NOT confirm P3 between Nagpur to Hwh – he will have to chase TC on train to get confirmation – as Railways cannot at the last moment confirm verbally from each passenger whether he/she is willing to travel say between Nagpur to Hwh reservation boarding at Bbay UNLESS the passenger confirms the ticket - boarding at Bbay but reservation from Nagpur to Hwh at the time of booking the ticket (reason being discretion to travel unreserved for a few stations or to cancel the ticket is a Passenger's choice, Railways can't be expected to either make that choice or confirm the choice for each such Passenger under normal circumstances).

Reservation and other miscellaneous issues/problems in Railways

Problem 1

What if number of passengers is not equal to train capacity or number of coaches in other words capacity of train is fixed but the number of passengers is varying.

e.g. A train can only accommodate 3 AC 3-tier coaches and 8 II-tier sleeper coaches say for instance.

N.B. Reservation Quotas will have to go through a process of rationalization (of the fore-casted averages.) as described in Scenario 1a).

Problem 2

We have assumed that train capacity is exactly equal to average number of passengers i.e. 50. What if number of passengers is -

a) 52 or 60 or 75

b) 90 (a sustained number)

In case a) the train capacity can be increased by adding a few more coaches or the passengers might be kept on waiting list or drop a few stations on the route to decrease traffic. In case of b) Railways might decide to run Bbay Hwh mail thrice a week or introduce a new train such as Geetanjali.

In case the passengers are kept on waiting list the tendency of passengers is to cancel the ticket and typically book it on another date which can result in congestion points after some time. Railways might decide to run Special trains on such occasions or add coaches or increase capacity of trains by adding General class coaches where more people can be squeezed in etc. Congestion points typically occur in a certain month or months like Holiday/Vacation seasons where railways feel the need to de-congest.

Problem 3

Suppose number of passengers drops to say -

a) 48, 30, 25

b) or 10

In case of a) one might decide to change the route to include more stops or include more stops along the same route. Short term measure would be to continue the service with more stoppages or operate at lower capacity (fewer coaches).

In case of b) one might decide to drop or cancel trains e.g. during off – peak seasons.

Problem 4

Suppose if the number of passengers going to Wardha or Warangal via Nagpur is high (the Passengers travel to Nagpur via Bbay-Hwh and then from Nagpur to Wardha/Warangal via some other train).

=> Change route to include those stations or introduce more trains specific for that route or keep coaches which can be attached from Bbay-Hwh mail to the other train for Wardha /Warangal quota/reservation.

Problem 5

How much time should a train stop for at each and every station if both boarding and alighting passengers are to be taken into account.

Let us assume that the journey takes 8 hours and stoppage time is scheduled to be 5% of travel time.

=> 5% of 8 hrs = 0.4 hrs = 0.4 x 60 = 24 minutes.

Let us assume that the reservation quota is as shown in Table A.

For Akola,	No. of boarding passengers	=	15
For Nagpur,	No. of boarding passengers	=	10
For Tatanagar,	No. of boarding passengers	=	10
Total		=	35
No. of boarding passengers at B'bay		=	15 (Not to be taken into account)
Grand total		=	50
For Akola,	No. of alighting passengers	=	1
For Nagpur,	No. of alighting passengers	=	8

For Tatanager,No. of alighting passengers	=	11
Total	=	20
No. of alighting passengers at Hwh	=	30 (Not to be taken into account)
Grand total	=	50

Number of passengers alighting and boarding is twice number of passengers traveling which makes sense.

Number of passengers alighting and boarding other than those at terminal stations is 55.

For Akola, boarding and alighting passengers	= 15 + 1 = 16
For Nagpur, boarding and alighting passengers	= 10 + 8 = 18
For Tatanagar, boarding and alighting passengers	= 10 + 11= 21

=> Stoppage times will be as follows -

Akola = 16/55 x 24 = 6.98 minutes

Nagpur=18/55 x 24 = 7.85 minutes

Tatanagar = 21/55 x 24 = 9.16 minutes

Please note for 55 passengers boarding/alighting there are 24 minutes => 24/55 = 0.44 minutes /pass.

Or, 0.44 minutes x 60 = 26 secs /passenger

In actual practice the 5% of travel time fixed for Stoppage will depend on Time-Motion-Work study of alighting/boarding and the total number of passengers boarding and alighting (We have done the Reverse calculation as Time-Motion-Work study on alighting/boarding was not available).

Airline Reservation System

We assume that Business class passengers are always lesser than Economy class passengers. Also in airlines number of business class seats and economy class seats are often fixed in number depending on type of aircraft.

Suppose for an aircraft there are 20 Business seats and 30 Economy seats.

Different traffic scenarios and problems/issues in context of CRM and Logistics (Airlines)

Problem 1

Number of economy class passengers is fully booked but number of business class passengers is 1.

=> Promote business class using CRM/discounts/gifts/vouchers to lure frequent fliers or would be frequent fliers to fly Business class or convert part of the economy class passengers to business class by promotions. This is where CRM can play a role.

Problem 2

Suppose economy class passengers is 5 and business class passengers is 4.

=> Drop flights and give passengers to competition or to retain customer base operate flights with heavy discounts and lure the customers using CRM database – example short distance flights during night time.

e.g. Mumbai Delhi midnight flights by go-air at 50% discounts.

Or run smaller aircrafts with lesser capacity during those hours or routes e.g in the US, for internal routes Airlines operate smaller aircraft.

Problem 3

Mundane

– Traffic is high along a particular route => operate more flights

- Traffic is low along a particular route => operate lesser number of flights

Problem 4

To find out unique names of customers who have made more than 4 flights (the SQL query will be as follows) - select distinct(customerid), count(customerid) from customertable where count(customerid) > 4 group by customerid

To find out unique names of customers who have made more than 4 flights in the year 2012 (the SQL query will be as follows) - select distinct(customerid), count(customerid) from customertable where count(customerid) > 4 and year='2012' group by customerid, year

Problem 5

To find out which customers travel by which routes that have made more than 4 flights in year - the SQL query would be something like this -

select distinct(custid), count(custid), distinct(year), distinct(routeid), count(routeid) where

count(custid) > 4 and year='2012' group by custid, year, routeid

To find out which customers travel by which routes (at least twice) that have made more than 4 flights in year - the SQL query would be something like this -

select distinct(custid), count(custid), distinct(routeid), count(routeid), distinct(year) where

count(custid) > 4 and count(routeid) > 2 and year='2012' group by custid, routeid, year.

CONCLUSION

We have seen two distinct categories of problems and possible solutions in the Reservation Systems discussed so far, namely the quota system in Railway Reservation and its implications on train scheduling/operation and the CRM aspect in Airline Reservation systems.

Implications and potential applications

1. In Railway Reservation systems there is a process of rationalization of quotas and different Reservation scenarios possible under this quota system.
2. Also in Railway Reservation systems there are Logistical and Operational scenarios based on quotas and real-time reservation situations which impact scheduling of trains.

3. In Airline Reservation systems based on the CRM aspects various Marketing/Promotional strategies such as extra/free mileage, discounts, gifts, frequent flier programs etc can be worked out based on the problems/solutions illustrated.
4. Also in Airline Reservation systems based on real-time reservation information the operational/scheduling of Airlines/Aircraft is impacted.

Summary and Scope for further research

It is obvious from the illustrations of Railway and Airline Reservation systems that there is ample scope for further research into policies, rationalizing of quotas/reservations, marketing strategies/promotions, clustering of customers and operational aspects of the two important modes of transport.

APPENDIX

To determine forecast of daily/weekly/fortnightly or monthly passenger traffic between two locations Xi and Xj along route Rn.

To obtain this information we can determine the forecast for this year's data or the next year's passenger traffic data between two locations by looking at past history and applying a bit of statistical analysis.

e.g. If the route is Bombay-Howrah mail and we have a Data warehouse (accumulated past history of records taken over a period of time) of information akin to that stored in Table A/B which we can easily obtain from passenger bookings/reservations made in the past several years (historical data, say for Tuesday train – Bombay-Howrah mail for past 5 years).

Then it would be a simple technique of finding mean, mode, median as means of determining average (for past 5 years) – which is quite trivial and not recommended. Another technique would be to determine average by means of moving average for that route and particular week-day. Better yet would be technique of removing anomalies (peak and off-peak seasons) and then determine averages by moving average method. For peak and off-peak seasons/timings there could be another set of averages to determine forecast of daily/weekly/fortnightly or monthly passenger traffic between two locations Xi and Xj along route Rn

Using the above principles we can also determine forecasts for II tier sleeper and 3-tier AC and other category berths.

Similarly we can determine Economy and Business class passenger traffic for Airline passengers along a particular route for peak season timing, off-peak season timing and normal season timing.

Note – Initially the Routes Rn can be determined based on market surveys, once the Investor (could be Govt. or Private body/Institution or Public-Private-Partnership) develops the Routes/Infrastructure, he/she can begin collecting/collating passenger traffic data once the Routes are operational, store in a computer/data warehouse and use it for Forecasting the succeeding years passenger traffic. The more data is collected and collated, the more accurate the Forecasting becomes depending on the accuracy/reliability of the Statistical Analysis.