# Train-East Allocation Model

# Introduction

The UK’s well-established commuter and regional rail service provider, TrainEast, has recently introduced a new daily service, London–Margate–London, calling at Tonbridge, Ashford, Canterbury, and Dover. This is quite a strategic route because it directly interconnects the major stations. Train-East can achieve substantial revenue by fulfilling the passengers who plan their travel from one station to another and those who plan their travel from one end of the line to the other (Sichelschmidt, 1999). However, that is where significant difficulties arise for TrainEast in managing seat allocation. To maximize revenue, there are 500 seats available; however, the demand within each segment is different. We define intermediate stations as points that do not require seat allocation for sequential flights, as seats can be reapportioned depending on the load factor for the next flight(Yang et al., 2022) . Misallocation can lead to wasted seat capacity—either not having enough seats for high demand or having too many seats for low-yielding segments. This analysis focuses on three main objectives: These are (1) the identification of the optimum heuristic model in which to allocate seats for maximum revenue generation; (2) the requirement of minimum 10% demand for each station-to-station flight; and (3) the analysis of the success of 10% fare decrease that is expected to increase demand for flights to be 10% on total revenue.

# Methodology

Structured demand and fare data tables are used in the model for TrainEast’s seat allocation optimization. The demand table estimates the number of passengers for each station-to-station leg, and the fare table notes ticket pricing for each equivalent leg. The information presented serves as the basis for achieving the goal of optimizing revenues with the help of focusing on the O&D segments with high demand and fares. One feature that sets this model apart from others is the dynamic seat reallocation which allows passage of seats from one station to another once occupied by passengers and thus less available for other passengers boarding at following stations. This reallocation is essential for achieving optimum occupancy and total revenues for the multiple-stop route.

In the context of this model, an optimization model that uses either linear/or integer programming to determine the correct number of seats to be allocated to each segment maximizes revenue (Vickerman, 1995). This framework integrates vital constraints: a total seating capacity of 500 across the journey, avoiding any overbooking situation, and a minimum seat allocation policy, where a given station-to-station demand is decreed to have a minimum of 10% fill-up to avoid having significantly large gaps in the service provision in a particular transit path.

For change on scenario analysis, the above model is modified to assess the effects of a reduced fare by 10% espoused to lead to increased demand by 10%. In this case, all the fare values are decreased by 10%, and demand data for each segment are increased by 10%. This enables the model to determine the impact that the elasticity of fare reduction can have on seats sold and overall revenues, which in turn can provide TrainEast valuable information on possible financial implications of price changes.

# Interpretations and discussions

***DS3 also includes model results, which provide a summary of the major findings of the analyses and offer the overall conclusion.***

After applying Solver to the model, we obtain the following results for each component:

**a. Decision Variables are the number of seats allocated for each contender.**

***Interpretation***: To achieve this, seat opportunities for every station-to-station area are mathematically allocated according to demand in the specific segment and fare to be charged to get the highest possible earnings. High O&D traffic brands get more share, while higher fares generate higher revenues for the airlines.

***Result Discussion***: More seats are generally delivered in segments with the highest cover and frequency (London to Margate, Tonbridge to Margate), given their high revenue generation potential.

b. Revenue Contribution Table

Interpretation: This table shows the actual revenue by each st-to-st route using the number of seats and the fare for each route.

**Result Discussion:** The segments that received more outstanding funds also comprise the overall business sales. For instance, London to Margate or London to Dover would rank high on allocation, and as a result, their proportion of total revenue would also increase. This is in tune with the model's concept, which seeks to achieve the highest possible revenue.

**c. Utilization Table**

Interpretation: This table reveals the proportion of the most critical demand that both segments can still access after being allocated the number of seats shown on the route network map based on the capacity and existing demand for each position.

**Result Discussion:** The model also guarantees that each route's demand in MCLA can be covered to at least 10%. Nevertheless, high-demand segments may still possess some unsaturated demand if these seats can generate more revenues in other segments. The trade-offs justify this balance to optimize the revenue within the limitation standard for all firms within the industry, including seat capacity.

**d. Constraints Table**

Interpretation: Its purpose is to check the adhesion to the constraints of the model that has been introduced. First, each segment is allocated at least 10% of the total demand, and the total number of seats does not exceed 500.

Result Discussion:

The model satisfies these constraints in that it does not surpass Dallas capacity constraints while maintaining service quality threshold demands.

**Total Revenue Calculation**

Interpretation: Total revenue includes the sum of the seat allocation sales in the total revenue of each segment in this optimization model.

Result Discussion: This last figure determines the seat allocation strategy's ability to produce revenue. It facilitates evaluating the optimization exercise's effectiveness in meeting the TrainEast financial objective for this route.

**e. Applying Solver:**

Objective Function: The airline company should aim to increase total revenue and adjust seat availability with the help of an optimization model.

Constraints Applied:

**Demand Fulfillment:** Every segment must be assigned at least 10% of the total demand.

Capacity Constraint: The total number of seats in the various segments must not exceed 500.

Solver Output Interpretation:

Using Solver, it is possible to determine which segments are most profitable and allocate the seats more effectively based on every segment's demand and fare data.

With respect to sales revenues and serving the demand, the Solver's output under operation constraints guarantees an efficient allocation strategy.

**- Some Discussion of the Results and Practical Implications**

Revenue Maximization vs. Service Quality:

Some of the assumptions made in the model include the focus on general revenues, which may sometimes result in low seat supply in certain routes that generate less revenue. This could negatively impact customer satisfaction in some of these segments.

Certain customers may lead to low fares or less usage of TrainEast services; hence, TrainEast must ensure the achievement of a certain level of service while at the same time ensuring it generates maximum revenue to meet its financial objectives.

Capacity Utilization:

Such a model ensures the optimal utilization of all 500 seats, so there is no wastage of such capacity. This optimization fully utilizes each existing chair, which is paramount to breaking even, let alone making a profit, on a capacity-fixed service.

# Future Adjustments:

* Dynamic Pricing: If demand is unstable at certain times or periods compared to other times, fluctuating fares may also help increase revenue.
* Route-specific Adjustments: If some routes show systematic over- or under-demand, TrainEast might have an opportunity to increase/decrease the number of runs on particular routes or include more relevant ones to attain still higher levels of seat utilization.

# References

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