LEVERAGING THE POWER OF OPERATIONS RESEARCH AND DATA TO DESIGN AND MODEL COMMUTE

ORMAE

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Human activities consume resources. Commute is no different. It consumes significant chunks of energy and infrastructural resources across the globe. High resource consumption due to movement of goods and people is one of the major challenges that the modern world is facing. An average commuter in a congested city spends 100 to 150+ hours in traffic in a year.[1] This comes to about 2% of your awake life being spent on road negotiating traffic.

Environmental and health impact of these commutes are additional costs being paid by this planet and its habitats apart from precious resource consumption. While individual vehicles provide freedom of movement and convenience, they have led to challenges of pollution, chronic traffic jams and, inefficiencies of staying parked and low seat-usage. Public transport and shared mobility have been considered as an alternative to individual vehicles on account of these challenges.

But the adoption of public transit has always been stymied by factors of accessibility, frequency, and reliability. And enhancing these factors would be the key to adoption of public transit which has far less resource and environmental footprint. Identifying opportunities in resource utilization and improvement of usage of public transit, even in a small manner, can have a positive effect on a large scale.

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The challenge of adoption of public commute is essentially a challenge of right design at initial stage and right operations during execution phase. Right design and execution would mean leveraging the capabilities of say internet to locate current location (helps in reliability), capacity estimation of the systems (helps in optimal frequency), identifying and debottlenecking the congested points, right sizing of capacities, manpower scheduling to mention a few. The design and execution require specialized capabilities in data handling as well as computation, analytics, and optimization. Since we see this challenge as one of the most important ones being faced by humanity, we at ORMAE spend a significant amount of time honing our institutional capabilities that are needed for system and operational design of public commute by leveraging the power of modelling and operations research.

Mathematical modelling of a system and iterating it for multiple scenarios with an objective of minimizing the total costs or maximizing the total benefit, while adhering to operational limits is known as operations research (OR). ORMAE has a high focus on OR and we leverage it frequently to provide recommendations to our client's business problems. It is a difficult but surmountable challenge to render a commute system into a mathematical model by using the operating rules and the data being generated by traffic and public transport networks. The next step of design challenge is to iterate this data for realistic scenarios by leveraging the high computing power available.

Having focused on this problem on multiple occasions we believe that mathematical modelling of traffic and commute can be an important add-on to the system design of urban habitats and inter-regional railway systems. This is a problem that can be addressed by combined application of data analytics and operations research. The data analytics would be required to organize and to make sense of the large data that is being generated by these commute systems. The advanced algorithms of OR would be required to arrive at the best or most robust scenarios (called as optimal solution in OR parlance) for a given system.

We at ORMAE address these problems by dividing the modelling and solution design of commute system into three categories:

1. ***Designing the network structure:*** These kinds of problems would primarily involve studying the system for existing commuters, the demographic built-up of the city, and overall structure of the city network. Then iterating the urban commute plan to identify best output in terms of service levels, total cost, time spent by commuters on traffic, average distance travelled, average commute travel by each category of commuters. This challenge of right network design is usually deployed in greenfield projects. These problems are usually modelled as a cost minimization model while fixing the service levels and fixing the maximum allowed commute distance and time for the drivers as per the local regulations. These green field design challenges are not so frequent since almost every city has some form of public transportation available on which the clients want to improve upon.

2. ***Identifying the capacity needed in the system***: This challenge appears more frequently compared to designing the network using green field approach. Many a times, a network is very much in place on account of earlier designs and clients approach us to identify how should those networks be best utilized. In other words, it is about identifying how many vehicles (buses or trains) should be deployed by hour of the day to best serve the commuters. This problem has the challenges of cost-benefit analysis and trade-off between identifying the of number of vehicles vs service level and is constrained by capacity at end points, the total cost, turn-around time of the vehicles and terminal station and junction capacities.

3. ***Crew scheduling of public transport***: The third kind of challenge in public transport that can be usually addressed using data and OR capabilities in public transport is the crew scheduling for each bus/train along with manpower planning and planning of other resources like refueling recommendations and optimal preparation times at beginning of each route.

The idea of using OR and Data Science for optimizing the challenge of commute is just one example that demonstrates how power of these techniques can be leveraged for identifying opportunities and solve major challenges being faced across the globe.

At **ORMAE**, we are strong believers of use of these technologies for solving real world problems for our client's businesses. We have worked with clients as varied as food retailers to cement manufacturers to address the various challenges which their businesses face. Do you have a business or operational challenge that you feel need mathematical decisions? We would love to connect and discuss!

References:

[1] https://www.bloomberg.com/news/articles/2023-01-10/these-are-the-world-s-most-congested-cities

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Dr. Amit Garg, a Guinness World Record holder in Mathematics is the Founder and CEO at ORMAE. He has more than a decade of industry experience in Optimization and Analytics area in leading MNCs in USA like Amazon, Genesys, Penske to name a few. He completed PhD in Operations Research from Case Western University after completing B. Tech and M.S from IIT, Delhi. He has worked in various industries like Supply Chain, Transportation and Logistics, Automotive, e-Commerce, ITeS and Finance. He has expertise in Optimization Techniques, Mathematical modelling (MIP, IP, LP), Heuristics and Meta-Heuristics. He has applied these in solving complex large scale optimization problems in Supply Chain and Logistics. He is a mentor to various organizations and has been an honored guest in global conferences, Corporates and Universities. His world record was accepted by "Guinness World Records", "Ripley's Believe it or not", "The Book of Alternative Records, UK", "Limca Book of World Records".

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