

An Indian-Australian research partnership

**Project Title:** **Smart Fleet Management and Pricing for On-Demand Modes of Transportation**

**Project Number** **IMURA0601 (Xerox)**

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## Research Academy Themes:

**Highlight which of the Academy's Theme(s) this project will address?**

*(Feel free to nominate more than one. For more information, see [www.iitbmonash.org](http://www.iitbmonash.org))*

1. **Advanced computational engineering, simulation and manufacture**
2. **Infrastructure Engineering**
3. Clean Energy
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research
7. Humanities and Social Sciences

## The research problem

External Mentor from Xerox: Koyel Mukherjee

For the urban millennials, especially in emerging economies, driving their own cars to and from work is often not desirable due to traffic congestion, and associated stress, which takes a toll in productivity among other things. Hence, alternate transportation solutions are becoming increasingly important. Public transportation, while being a very popular, reliable and regular mode of transportation, can often lack first and last mile connectivity and the convenience for individual travellers is traded off for economy in pricing. This is because the routes and schedules for public transportation are optimized for the general population, using the demand information, and not for individual travellers. Therefore, the operations optimized for masses may not really fit the needs of individuals who are looking to switch to other modes of transport from driving their own cars, and hence act as deterrents for them to make the switch.

One common alternate mode of transport that is convenient to use is on-demand private transportation in the form of

traditional taxi rides. While this can be convenient, it can also turn out to be expensive for the individual commuters, and might often result in the taxis travelling a lot of distance, with no customers on board, also known as dead kilometre. As a result, taxis are often not willing to serve certain types of requests or they may charge very high prices, and in fact vehicles are often unavailable at peak demand hours to serve commuter demands. All of these factors take the convenience out of using this mode of transport.

A possible solution to the above problems is the use of **smart fleet management and pricing for private on-demand transportation service providers**. The overall goal is to improve the availability of rides, and to make it a more appealing mode of transportation for individual commuters as well as drivers. This would require approaching the problem in a phased manner, each requiring extensive research.

The four phases of the research program are outlined below:

- 1) The first phase would be to learn demand patterns across space and time, the dependencies between different types of demands, and finally, build models to predict the demands accurately in real-time.
- 2) The second phase would be to explore the space of acceptable pricing for different types of demands for taxi drivers. The type of demand refers to the source, destination and time of the day, among other parameters. These parameters determine the route of operation, the associated cost due to traffic jams, and the probability of getting new demand at the end of the journey, which determines the expected profit. Our proposal for this phase is to design a truthful auction and payment mechanism in order to estimate the true prices for each type of demand, without allowing individual drivers to game the system, for a fair solution for both commuters and drivers.
- 3) The third phase would be to use static optimization algorithms and techniques for fleet management, optimizing the overall system welfare. This would involve planning regarding the number of vehicles required, the placement of vehicles, and what types of demands to assign to which drivers (in other words, routing the vehicles), for a system optimal experience, using the demand arrival model, derived from historical demand data, the pricing model and mechanism and also using network simulation for modelling the road network.
- 4) The final phase would be design a quick, reactive scheme that can dynamically adjust the plan of demand allocation to drivers and routing vehicles for re-optimizing in the face of real-time changes in demand and other conditions such as traffic congestion etc. on major routes.

One can potentially extend the application of the proposed solution to other type of on-demand private transportation, such as commercial shuttles. Initially, we plan to use datasets such as the NY taxi data that are publically available.

## Project aims

The overall goal is to improve the availability of rides, and to make it a more appealing mode of transportation for individual commuters as well as drivers. This would require approaching the problem in a phased manner, each requiring extensive research.

## Expected outcomes

Outputs:

- Prototype Software for smart fleet management that includes state-of-the-art models and algorithms.
- 2-3 good quality publications in this area.

Outcomes:

- Better use of smart, on-demand transportation,
- Better fleet management and pricing mechanisms for on-demand fleet operators.

## How will the project address the Goals of the above Themes?

*Describe how the project will address the goals of one or more of the 6 Themes listed above.*

The project will involve the development of models and algorithms for fleet managers which will, thereby, aim to yield better utilisation of on-demand, reduce the burden on urban infrastructure, reduce emissions,

and improve public transport use.

## Capabilities and Degrees Required

*List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.*

Essential:

- Operations research, optimisation
- Graph theory and graph algorithms
- Algorithm development
- Masters in Computer Science or Operations Research
- Programming in C/C++

Desirable:

- Knowledge of CPLEX, Matlab, R and other software packages
- 2-4 good publications
- Knowledge of the key issues in on-demand intelligent transport systems

## Potential Collaborators

*Please visit the IITB website [www.iitb.ac.in](http://www.iitb.ac.in) OR Monash Website [www.monash.edu](http://www.monash.edu) to highlight some potential collaborators that would be best suited for the area of research you are intending to float.*

Please provide a few key words relating to this project to make it easier for the students to apply.

**Algorithms, operations research, graph theory, transportation**