An agent-based model that analyzes commuters' travel data

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Credit: Karolina Grabowska from Pexels

The introduction of smartcard ticketing for Singapore's public transport system has enabled A*STAR researchers to provide valuable predictive data on potential train overloading. This will enable system planners to

address critical bottlenecks as the system stretches to accommodate an expanding population.

Over one million commuters—roughly 20 per cent of Singapore's population—use the mass rapid transit (MRT) system every day. With the population slated to increase by 26 per cent by 2030, this growth needs to be managed in a way that prevents system delays and overcrowding. A suboptimal transport system could lead to dissatisfied customers and higher economic costs.

To conduct their investigation, Christopher Monterola and colleagues at the A*STAR Institute of High Performance Computing used a modeling technique known as an agent-based model (ABM), which identifies key individual influencers, or 'agents', in a complex system and models them in a relatively 'natural' way. The team chose three tractable agents: the commuters, the train and the station. Unlike other transportation models, the ABM can consider interactions between agents.

The team examined two main problems that lead to travel delays: overloading and overcrowding. By varying the train's loading capacity (the maximum number of commuters a train can accommodate at a given time), the team identified a threshold capacity: beyond this tipping point even a few additional commuters produce a cascade of delays. Similarly, more passengers waiting on crowded platforms in popular routes may also significantly increase delays and extend travel times.

Prior to its use for scenario planning, the model was experimentally validated using a week of Singapore smartcard data, which corresponds to 14 million journeys. The data collected for each journey included the anonymized smartcard ID, journey ID, date, origin and destination stations, 'tap-in' and 'tap-out' times, and the distance traveled.

The model can be used to assist MRT system planners in alleviating

strains on a system should it become overloaded through the provision of real-time information on threshold capacities and 'bottleneck' stations.

Monterola says his team is passionate about finding ways to improve the robustness and efficiency of the MRT system. "This work is scientifically challenging, but more importantly, it is socially relevant," he explains.

Other transportation systems could also use the model, which can be "augmented to work with real-time data, to enable a livestream view of all commuter movement in a city," says Monterola. The team is currently working with behavioral scientists to interpret the influence of these system variables on commuter satisfaction—perhaps ultimately even at the individual level.

More information: Legara, E. F., Monterola, C., Lee, K. K. & Hung, G. G. Critical capacity, travel time delays and travel time distribution of rapid mass transit systems. *Physica A* 406, 100–106 (2014). dx.doi.org/10.1016/j.physa.2014.02.058

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