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# Optimising the crowd with smart technologies

## SMU's Professor Lau Hoong Chuin is leading a team to solve urban problems of crowds, queues, and congestion

CITIES are chaotic constructs, pulsing with the ebb and flow of human beings and vehicles. Making sense of and creating some order within them is what computer science professor Lau Hoong Chuin, Director of the recently set up Fujitsu-SMU Urban Computing and Engineering (UNiCEN) Corp Lab at Singapore Management University (SMU), aims to do.

He leads a team that designs methods and systems to optimise movements in taxi queues, convention centre crowds, maritime logistics and last-mile deliveries.

The work that will come out of the lab, he hopes, will not only ease queues and congestion but also reduce the number of vehicles on the road and cut down on carbon emissions. The key research challenges are mining information on people and freight movements, establishing insights and behavioural patterns, and designing intelligent decision support systems that perform resource planning and scheduling in operational settings.

For example, the lab is working on a topic close to Singaporeans' hearts: how to ensure taxi supply is matched with demand in real time.

"It's about making inference and optimisation under uncertainty. Given the enormous amount of data collected from sensors and mobile devices, can we anticipate demands and accordingly guide selected taxis to move voluntarily to sources of demand?

"The challenge is that taxi drivers have their own perspectives and may not necessarily follow instructions; so this means we need to compute accurately the probability that a given driver will act according to given information," he said.

The UNiCEN Corp Lab was set up in October 2014 as part of a five-year collaboration between SMU, Japanese information technology (IT) services giant Fujitsu, and Singapore's Agency for Science, Technology and Research (A*STAR).

The parties agreed to set up a S$54 million Urban Computing and Engineering Centre of Excellence. The centre is supported by the National Research Foundation under the Corp Lab scheme.

Participants in the lab include SMU faculty and students as well as Fujitsu researchers. In total, more than 50 people will work on projects at the lab, located in SMU Labs at the junction of Stamford Road and Armenian Street.

### From theme park to taxis and conventions

With Fujitsu being a key technology provider for the 2020 Tokyo Olympics, the company hopes to create ways to manage large crowds, tested in Singapore, which can be used during the games itself.

A precursor to the lab's current work is a project with Resorts World Sentosa to help manage crowds as well as optimise the visitor experience.

"A theme park is like a microcosm of a city. Every day, tens of thousands of visitors pour into the park. Queues and crowds hamper their experience," he explained.

Prof Lau's team at SMU's Living Analytics Research Centre developed a crowd monitoring and control system, and a mobile app. Users of the app can input ride preferences, schedules and group sizes, along with other factors like height, weight and health restrictions. Like a car's GPS device, the app is interactive in that it provides the best recommendations in real-time to individual visitors based on their preferences, and takes into account current weather conditions, operational status of rides and queue lengths.

"This project provided the opportunity to develop and fine-tune techniques and technologies for interactive crowd management in solving larger urban issues, like reducing taxi queues," he said.

What is interesting is that the mobile app, coupled with the underlying intelligent system, is capable of, monitoring and co-ordinating crowd movements.

"The aim is to help both commuters and taxi drivers make smart decisions in real time through the mobile apps," he said.

While technology players like Uber and GrabTaxi have helped commuters get the cabs they want, Prof Lau said the UNiCEN Corp Lab aims to take this to a higher level of complexity by proactively and dynamically matching supply and demand at scale, especially in situations where there is a transient surge of demands due to large events (such as the Singapore F1 Grand Prix) or inclement weather.

"We want to study how to do both in a location with large crowds as well as islandwide and be able

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> **Professor Lau Hoong Chuin, Professor of Information Systems and Director of Fujitsu-SMU Urban Computing and Engineering (UNiCEN) Corp Lab**

to anticipate where the taxi queues will be, rather than simply react to it when queues have developed. If you can actually predict half an hour in advance what is going to happen to taxi queues, you can reduce a lot of unnecessary wait times."

Other than the taxi problem, Prof Lau's team is also working with Suntec Singapore Convention & Exhibition Centre on an app to improve the experience of thousands of visiting delegates.

"It takes a lot of effort to concoct your own itinerary to attend the various demonstrations and talks within a convention, and meet with different people you want to meet. Wouldn't it be nice if you have an intelligent personalised software agent to help you plan your activities on-the-fly according to your preference and needs," Prof Lau said.

Again, the underlying aim is to help individuals avoid long queues, hence the app would recommend eateries to avoid lunch crowds. The same app can also be extended to large shopping malls and leisure facilities to help the general public, as well as benefit retail and food and beverage outlets, he added.

### From taxis and commuters to ships and freight

The idea of dynamic demand and supply matching is not only restricted to people flows. UNiCEN Corp Lab is tackling the problem of co-ordinating maritime and urban freight traffic in Singapore.

Singapore is the busiest port in the world in terms of shipping tonnage, with some 120,000 vessel calls annually. As cargo volume and maritime traffic grow, port authorities want to see higher level of vessel co-ordination sailing through crowded and narrow Singapore waters for safety and efficiency purposes. The UNiCEN team will develop intelligent co-ordination and planning algorithms that can aid in effectively mitigating hotspots and provide customised guidance to different stakeholders involved in the maritime traffic management.

And as freight enters the port, the urban challenge is last-mile logistics, which is the movement of goods from the port to the points of consumption.

Singapore's logistics industry is largely fragmented and uncoordinated, and operators have no incentive to share orders with one another.

However, congestion will only increase as freight volumes grow, as a result of growing trade, e-Commerce, and an ageing population which requires more home deliveries, Prof Lau said.

"For example, instead of company A and B both sending their own trucks to a particular shopping mall and jamming up both the roads and the loading and unloading bays, it would be more efficient if the logistics providers can consolidate their loads onto fewer trucks and co-ordinate the timings of their deliveries. This would in turn increase flexibility, and reduce traffic and carbon footprints within the city," he said.

Prof Lau said that for such a scheme to work, operators need to derive win-win solutions in collaboration. He is leading a team to design market mechanisms and systems that enable different stakeholders involved in last-mile logistics to jointly improve operations. With the move toward green logistics and pressure of manpower shortage, he envisions the establishment of a national-scale e-Market platform where such technology can be deployed to enable dynamic matching of delivery demands with limited logistics resources.

"The work we are doing at UNiCEN is aligned with Singapore's vision to be a Smart Nation, a key aspect of which is to make good use of technology to help people and businesses make smart decisions. We will draw on our expertise in methods and software systems for planning, scheduling and decision making that combine artificial intelligence, agent-based modelling and simulation, large-scale optimisation, mechanism design, behavioural economics and computational social science to contribute to this national effort," said Prof Lau.

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