Simulation of COVID-19 Spread

Healthcare

Problem

Researchers wanted to create a model which could show the spread of COVID-19 in Hong Kong and identify vulnerable areas. However, Hong Kong has very unique conditions, especially in terms of COVID-19 and so this was harder to do than first thought. It is a hyperdense urban environment, a major transport hub, and the economic engine for eastern Asia.

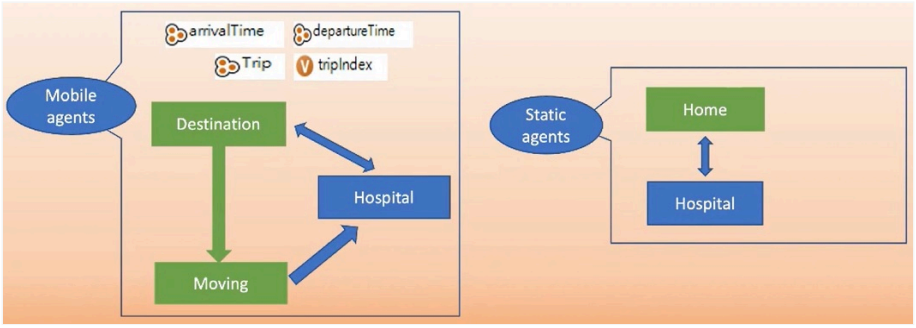
Using secondary data in Hong Kong and a 3D agent-based model the researchers aimed to:

- Simulate how COVID-19 spread in Hong Kong.
- Identify which areas or population were the most vulnerable.
- Evaluate the effectiveness of COVID-19 non-pharmaceutical interventions and vaccinations.

The researchers used a large array of data, including from the Hong Kong Travel Characteristics Survey 2011, points of interest (POI) data, building data, and COVID-19 data.

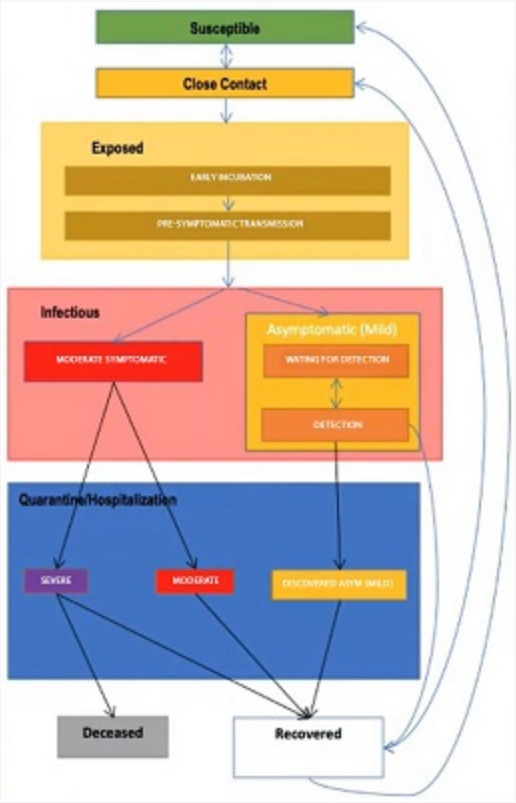
The first agent-based mobility model created included two main agents – mobile and static.

Mobile agents were considered to be the younger generation which went to school, the office, and such places, while the static agents spent more time at home. Four major locations were used – restaurants, shopping malls, schools, and workplaces. There was also a separate smaller category for other places.



Mobility model

In addition, parameters and data were taken from literature such as publications or from government reports. This information came from Hong Kong, mainland China, or east Asia.



SEIQR model (click to enlarge)

Results

From the mobility and SEIQR models, researchers created a scenario analysis, and five different simulation models were configured:

1. M0 – the default simulation model without any

70% efficacy level.

5. M4 – the implementation of M1 + M2 + M3.

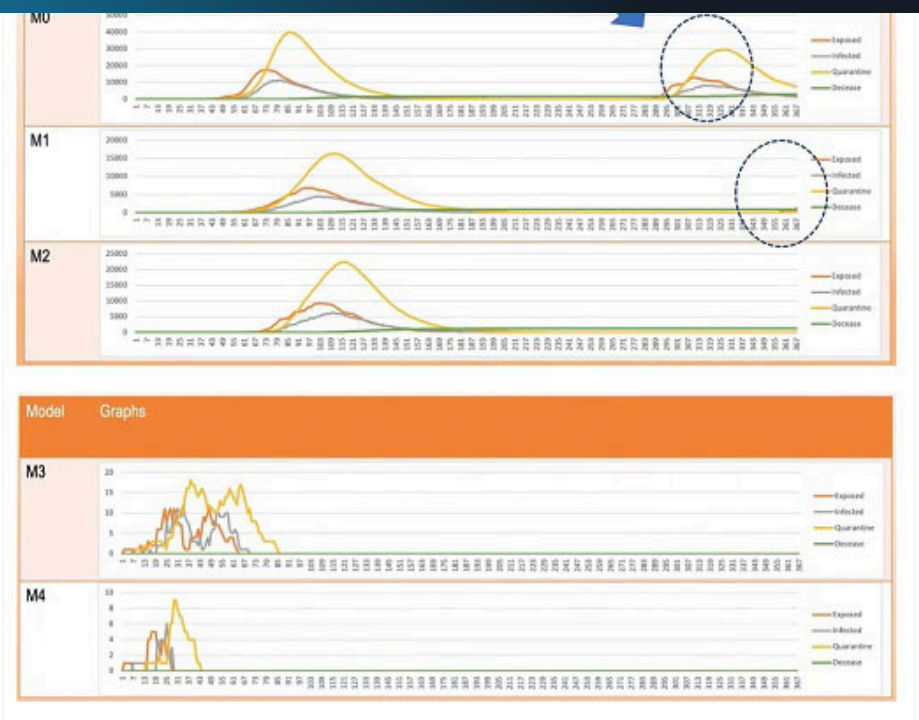
The population of the model was 10% of the total Hong Kong population. This amount was chosen in order to have a faster model run time, while also having enough infections in the model. The number of POIs was around 250,000 and the model period was for 1 year.

When the model was run, the different parameters which could be adjusted were displayed. Then the results were calculated and displayed graphically. These could then be downloaded to Excel using AnyLogic functions.

In the illustrations below the effectiveness of the interventions can be seen: M4>M3>M2>M1>M0. Based on M0-M2 the second wave was predicted to occur if there were no vaccinations.

Models	M0	M1	M2	M3	M4
Total Infected per 100K Pop.	34,881	17,434	14,620	3	1
Total Severe Cases per 100K Pop.	5,870	2,922	2,457	1	0
Total Deceased per 100K Pop.	501	244	213	0	0

Overall results (click to enlarge)



Overall results graphically illustrated (click to enlarge)

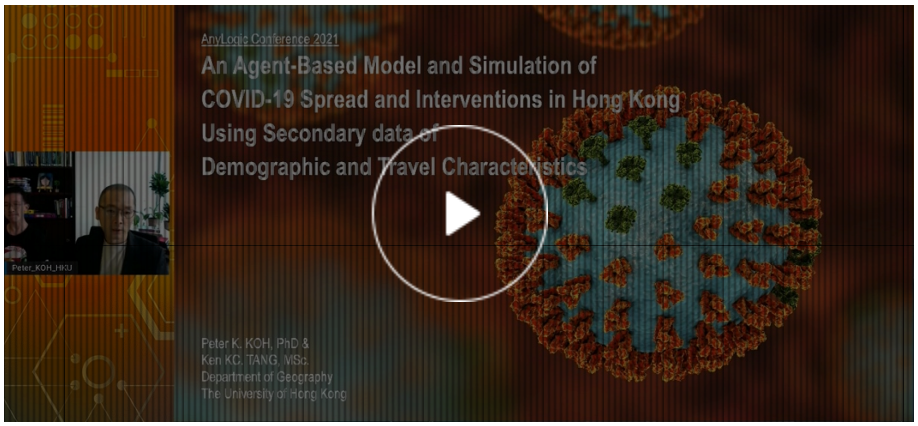
District level results could be displayed to identify which areas were riskier for infections. The top three high risk districts included the center of the business and commercial areas of Hong Kong.

Other results included age and gender, and the effective reproductive number.

A final conclusion was that despite the effectiveness of the COVID-19 vaccination, non-pharmaceutical interventions still needed to continue, possibly for years.

In the future, a number of other factors could be considered, including using new types of data, using more geographic approaches, multimethod modeling with system dynamics and discrete event models

Conference 2021.



Similar case studies

MORE CASE STUDIES

DOWNLOAD