STOCHASTIC MODELLING OF COVID-19 TRANSMISSION AMONG VISITORS OF CANADA'S WONDERLAND

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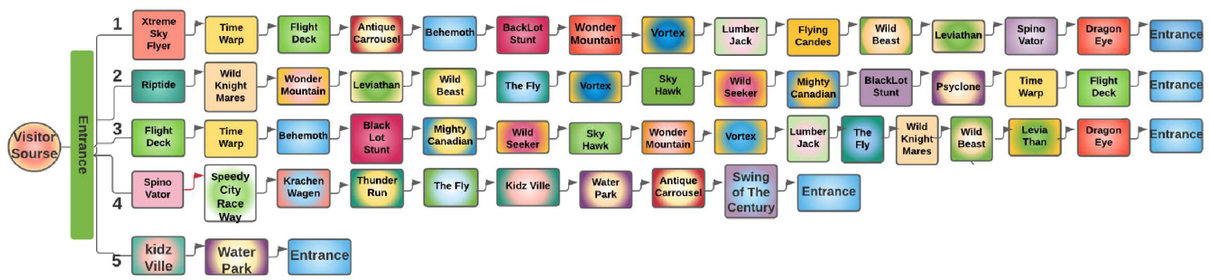
INTRODUCTION

COVID-19 is a contagious disease that results from the novel strain of coronavirus. Since the first interhuman transmission case reported in Wuhan City, Hubei Province, China, it has caused widespread disruption to businesses worldwide, particularly tourism and hospitality industries. Mitigating the epidemic and reducing fatalities requires answers to critical questions on airborne and surface transmission as well as the efficacy of antiviral pharmaceutical or non-pharmaceutical interventions. Due to a robust vaccination rollout, the province of Ontario has begun reopening including the opening of Canada's Wonderland at limited capacity.



A model to predict the number of cross-transmission cases in the theme park is in need to estimate the risk of visitors and propose mitigation strategies for a safe reopening. The behaviour of guests through preferred ride itineraries coupled with the transmission dynamics of the virus are taken into consideration.

OBJECTIVE

This project assesses the impact of non-pharmaceutical interventions such as physical distancing and mask-wearing under different vaccine coverages to the spread of the virus for visitors at the theme park.

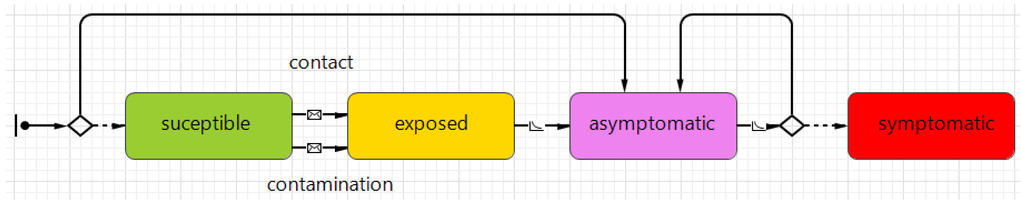
METHODOLOGY

SEIR model is employed to track the number of visitors who are susceptible to infection, exposed (infected but not yet infectious), actively infected, and have recovered from COVID-19 on a particular day.

$$\begin{cases} \frac{dS_i}{dt} = -\beta(1-\epsilon_i)I(t)S_i(t) \\ \frac{dE_i}{dt} = (1-\epsilon_i)\beta I(t)S_i(t) - \gamma E_i(t) \\ \frac{dI_i}{dt} = 0 \\ \frac{dR_i}{dt} = 0 \end{cases} \quad \text{for i} = 1, 2, 3$$

If the subscript is 1, then the visitor is not yet vaccinated, subscript 2 indicates partially vaccinated visitors, and subscript 3 indicates the visitor is fully vaccinated.

An agent-based simulation of park-goers at Canada's Wonderland is implemented in Anylogic. The model replicates the vaccination status of the province stratifying guests into three classes – unvaccinated, partially (one dose) vaccinated, and fully (two-dose) vaccinated.



Several scenarios at various capacities on the 134-hectare theme park are evaluated using several group itineraries and demographics to identify an optimal plan that generates profit at minimal virus transmission.

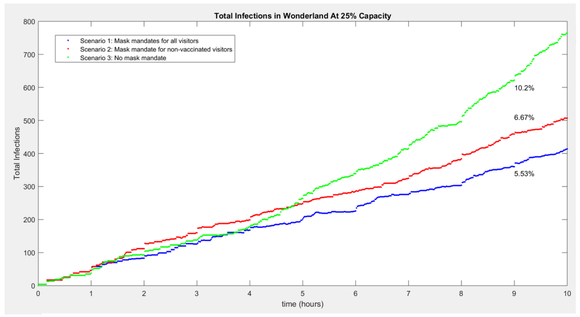
RELATED LITERATURE

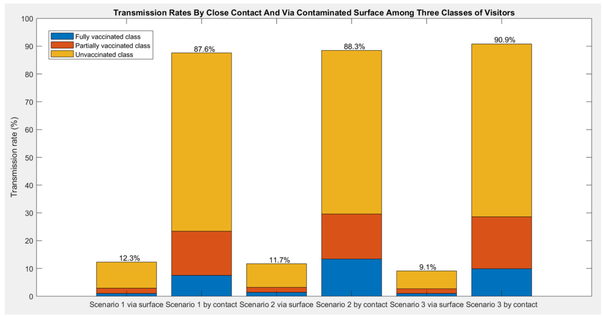
Research is often built on something that is already out there. Cite key references that you looked at while conducting your study.

ANALYSIS

CURRENT VACCINATION COVERAGE

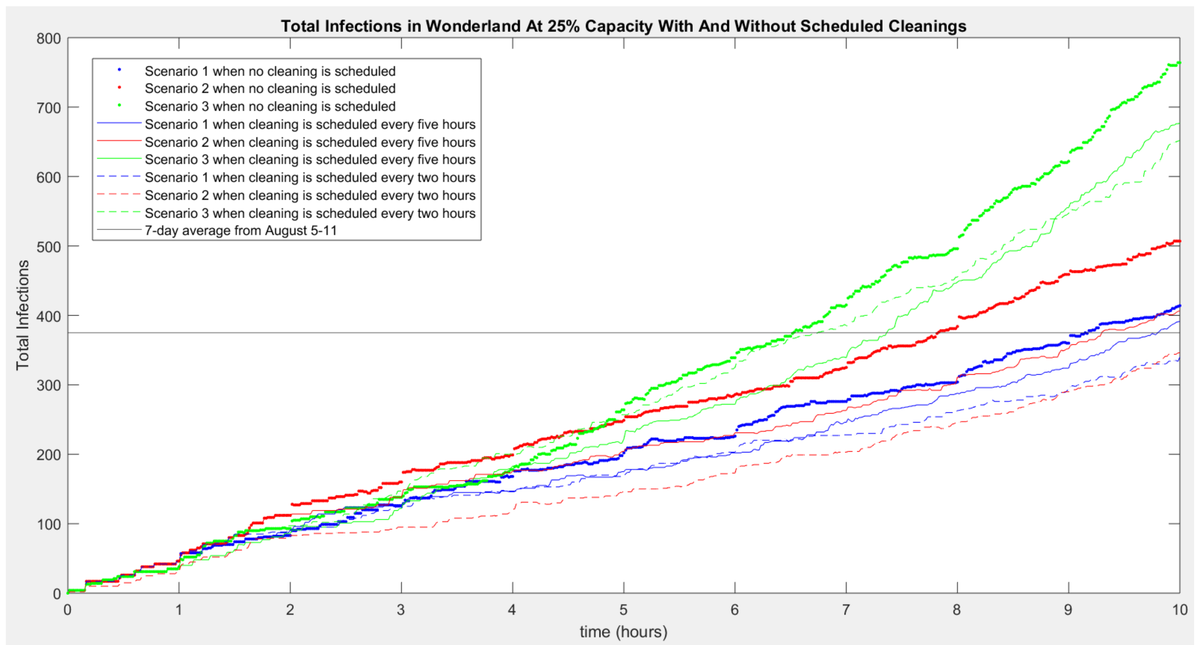
As of August 5, 2021, 71.1% of Ontario residents have received at least one dose, and 62.1% of them are fully vaccinated. As the province of Ontario moved into stage 3 of its economic reopening plan, Canada's Wonderland is operating with a 25 percent capacity limit. The projected transmission rates among three classes of visitors are as follows:





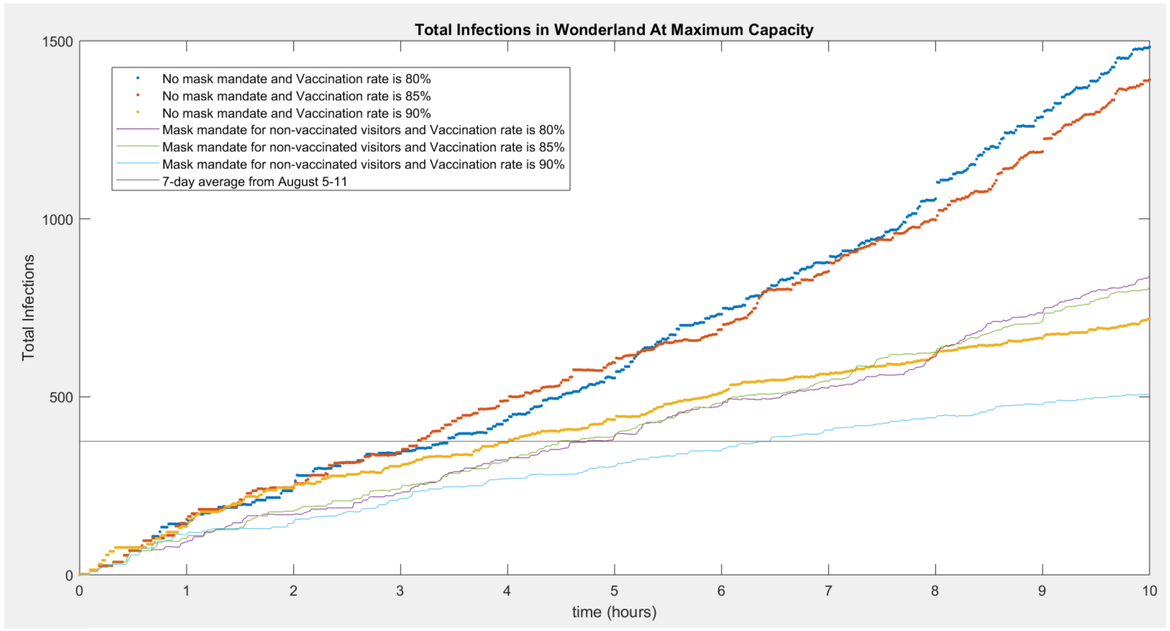
Simulated data show that cross-transmission mainly occurs among unvaccinated visitors with or without personal protective equipment (PPE), and transmission via contaminated surfaces is minimal compared to transmission by close contact with infected individuals.

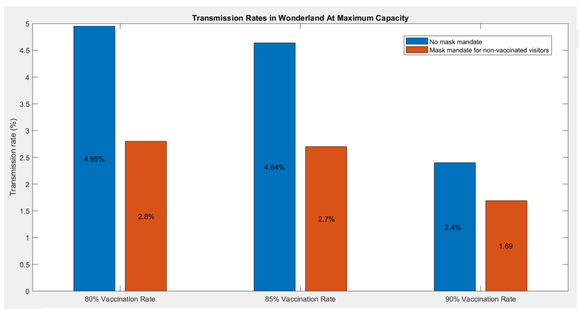
It suggests that scheduled cleanings diminish infection cases in Wonderland. The safety threshold is defined by the recent 7-day average of daily reported cases in the community.

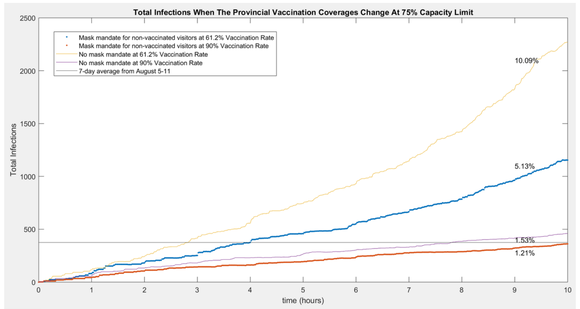


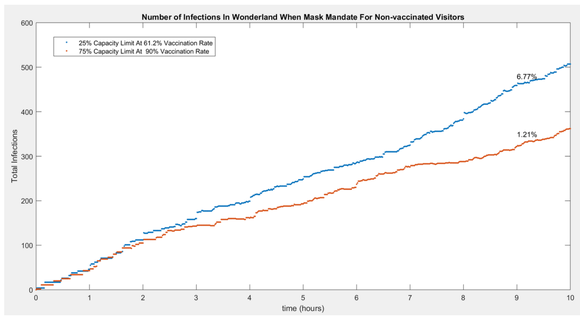
HERD IMMUNITY

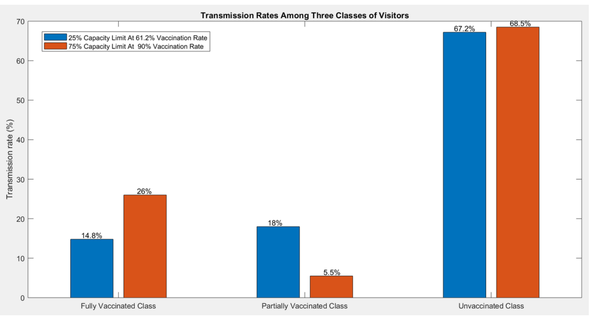
The rate of 90% should be the target of the vaccination program in order to flatten the infection curve among park-goers. We recommend operating Canada's Wonderland at 75% capacity once the province of Ontario achieves this threshold and mandating mask-wearing for unvaccinated individuals.







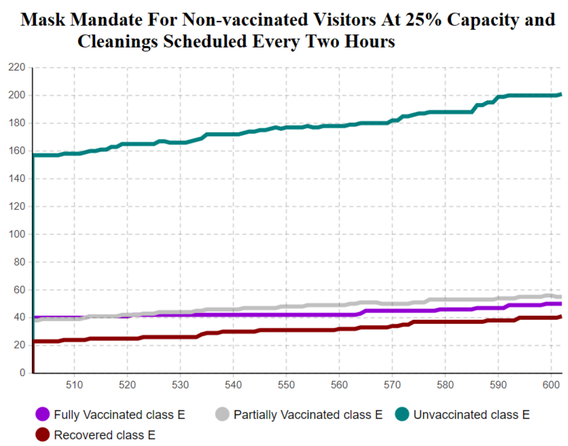


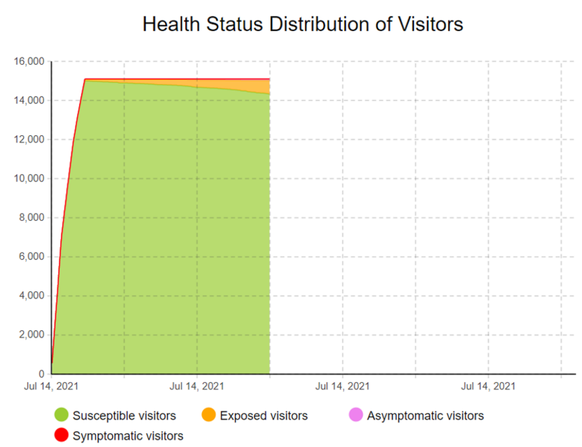


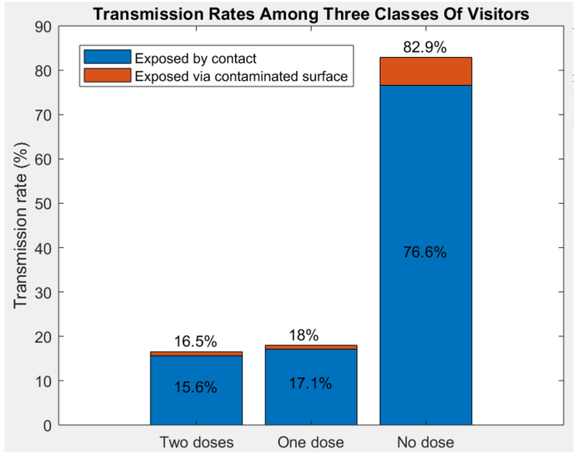
CONCLUSION

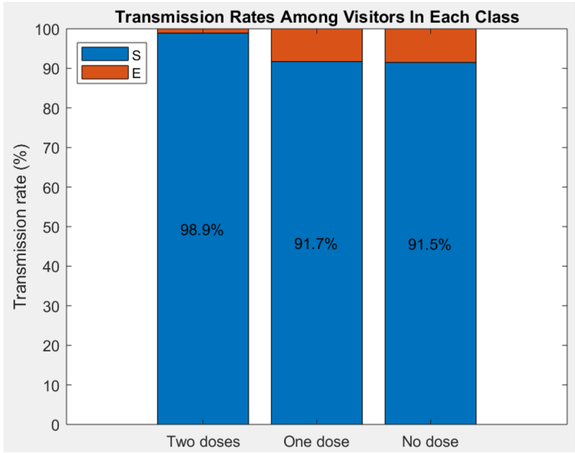
The simulations demonstrate that the mechanisms of vaccination, visitor screening upon arrival, mask-wearing and scheduled cleaning are important to reduce viral spread in the park. Furthermore, viral spread is the most rapid among unvaccinated visitors.

Recommended Scenario At The Moment:

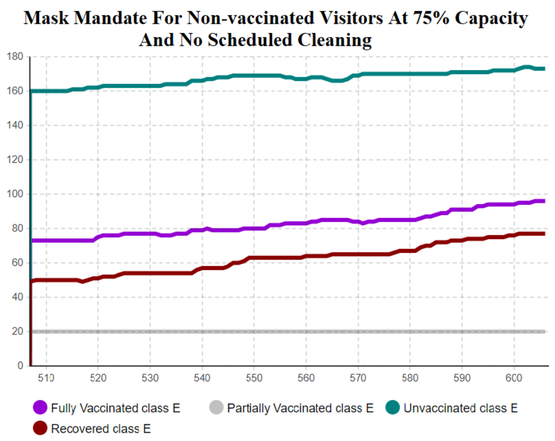


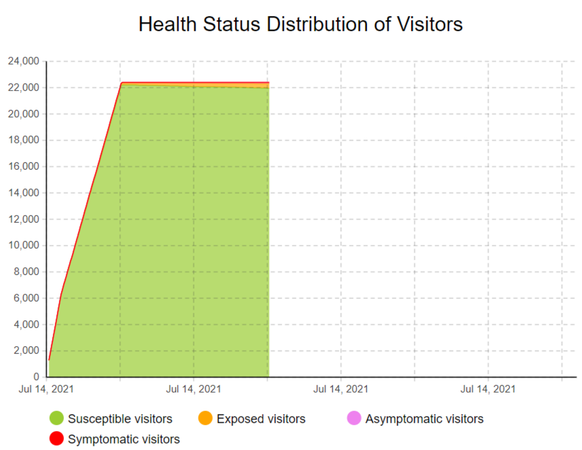


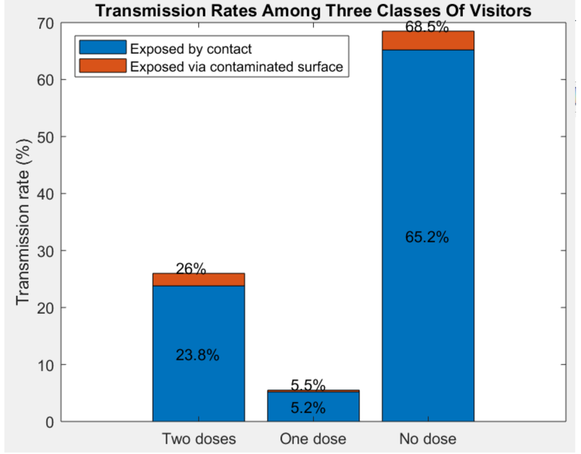


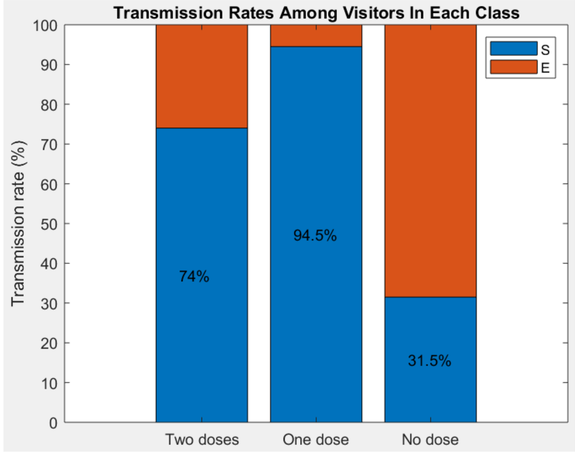


Recommended Scenarios When 90% Vaccination Rate is Reached:









TOOLS USED

anylogic®

MATLAB

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