Summary: The Impact of Elevator Usage and Zoning on High-Rise Building Evacuation

A UN study indicates that 68% of the world's population is expected to live in cities by the year 2050. With the increasing need for living and working spaces in cities, there has been a surge in the number of high-rise buildings being built. With the ever-increasing heights of the buildings, evacuation becomes more and more of a challenge. High-rise buildings serve multi-purpose functions such as housing, commercial spaces, offices, etc. When dealing with large populations occupying such spaces, the use of only stairs for the purpose of evacuation does not yield favorable results. Especially after the events of 9/11 at the World Trade Center towers, it was a necessity to investigate and optimize the use of elevators for the purpose of evacuation. With a number of studies that have been carried out by various researchers, the benefits of using elevators for reducing the total evacuation time is unmistakable. Areas of research that further study, lie in the human behavioral aspect of evacuation and ways to optimize the use of elevators for the quickest evacuation strategies possible. This thesis was carried out in order to shed light upon some of the variables that affect the optimization of elevator usage.

The parameters considered for this study were the number of available elevators for evacuation, number of people using the elevators during emergency evacuation, maximum waiting time for elevators and the impact of uneven elevator zoning in the building on the total evacuation time. Using the Pathfinder evacuation modelling tool, a hypothetical building consisting of 37 floors was simulated based on the layout of 100, Bishopsgate which has been constructed in London, UK. The design of the simulated building comprised of a total of 25 elevators and two sets of stairs in the core of the building. The heterogenous population included a 5% of population having movement impairments and this has been included in the simulation. A time period of 10 minutes was taken as the waiting time for the elevators in the base case and then varied to study it's impact on total evacuation time. Based on the convergence criteria set, the results were obtained for six scenarios that were simulated over and above the base case. The scenarios involved a change in the number of elevators by +/-20%, increasing the waiting time by an additional five minutes and an indefinite waiting time and one scenario where the number of elevator users were increased by an additional 5% by simulating a total of 10% of agents being wheelchair users. One scenario involved the use of only the elevators for the total evacuation.

The results obtained showed clearly that the impact of the number of elevators is negligible unless the number of people using the elevator changes. This increase in elevator usage was dependent on waiting time. Changing the behavior of the agents to have an increased level of elevator usage also had a positive impact on the total evacuation time. Most importantly, utilizing an unevenly zoned elevator system indicated results that were counterintuitive. While studies in the past showed a drastic decrease in the total evacuation time for scenarios involving the use of only elevators in evacuation, the output of this study showed that with unevenly distributed zoning, there is a sharp increase in the time required for total evacuation. Usually, conversation pertaining to the zoning philosophy includes discussions regarding the ingress time, peak traffic flow, density of people, etc. Results from this study indicate that the location of transfer floors has a considerable impact on total evacuation time and needs to be duly considered during the early stages of design.