

## An Optimal Allocation for Fire Hydrant Distribution in Urban Area: A case study in Bangkok, Thailand

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### Abstract

This study addresses the optimization of fire hydrant locations in a high-density metropolis. This work uses Bangkok, the capital city of Thailand, as a case study. The research integrates Linear Programming (LP) and Geospatial Analysis to evaluate the current infrastructure of 23,476 hydrants against 8,344 historical fire incidents (2022–present). Two primary mathematical models were formulated: the Minimum Set Covering Problem (MSCP) to determine the minimum resources needed for total coverage, and the Maximal Covering Location Problem (MCLP) to maximize service under resource constraints. The study also introduces a heuristic for installing new hydrants in underserved districts. The results indicate that while theoretical global coverage is possible with as few as 53 strategic points (at an extended 3.6 km radius), practical urban safety requires a denser network with a service radius of 300–500 meters. Sensitivity analysis is performed for different coverage distances and the number of available hydrant locations.

**Keyword:** Optimization, Fire Hydrant Distribution, Set Covering Problem