

## **Road Network Vulnerability: A Nationwide Analysis of 69 cities from Japan**

Nur Diana SAFITRI, Johan Rose SANTOS, Maya SAFIRA, Varun VARGHESE,  
Makoto CHIKARAISHI

E-mail: dianasafitrinds@gmail.com

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### **Abstract**

Japan has frequently witnessed natural disasters including floods, tsunami, and earthquakes. Such natural disasters have disrupted the day-to-day life of its citizens, while having severe impacts on the road networks. The resulting damage to the road networks causes a reduction in the overall efficiency and the level of service. Moreover, because of the damaged network, the access to the affected areas get destroyed, leading to a food supply and water crisis. An efficient road network serves a major driving force for economic growth, while also serving as major lifeline support during disasters. However, there is not much evidence on how during disaster events, various city level characteristics would affect the efficiency, vulnerability, and robustness of road networks. This study aims to investigate the road-network vulnerability of Japanese cities by formulating the following three objectives. Firstly, we estimate the level of network efficiency in 69 Japanese cities using topographical elements in its undisturbed, ideal state. Secondly, we estimate the level of network-robustness under simulated random and targeted attacks. Finally, a meta-regression analysis is conducted to estimate the impact of city-level parameters including the financial status of cities on network efficiency and robustness indicators. A nation-wide comparison will present new knowledge with respect to how random and targeted attacks affect efficiency levels. A comparative analysis between cities also will add new knowledge regarding how different city-level parameters will affect road network vulnerability. The parameters tested in the regression analysis include city-size, population, mode share, average trip length, and the financial status of the city. The empirical results of efficiency estimations in undisturbed and during attacked states showcased the variation across cities. Cities such as Shiogama, Omihachiman, and Tokai performed better than the others. Meanwhile, the analysis of the impact of different city-specific variables showcased that population has significant relationships with network efficiency indicators. In addition, variables pertaining to a city's fiscal health also showcased significant relationships with road network vulnerability. These evidences would be beneficial to policy-makers to prioritize their budgets and focus on improving the efficiency and robustness of its networks.