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Vulnerability Analysis of Complementary Transportation Systems with Applications to Railway and Airline Systems in China

Min Ouyang¹, ZheZhe Pan², Liu Hong^{3*}, Yue He⁴

Abstract: Most of existing studies on vulnerability analysis of multiple infrastructure systems mainly focus on negative effects of interdependencies, which mean that failures in one system can propagate to other systems and aggravate the initial damage. In reality, there also exist positive effects of interdependencies, which are shown in complementary systems and mean that if one system fails another system can provide alternative services to satisfy customers' demands. Different types of transportation systems in a city or country are typical complementary systems. Taking railway and airline systems in China as an example, this paper proposes a network-based approach to model the vulnerability of complementary transportation systems, and based on this model, this paper further introduces a dynamic complementary strength metric, which can help decision makers design or select better complementary topologies from the vulnerability perspective. Also, based on a simple genetic algorithm, this paper analyzes whether critical components for single systems are still important when taking two systems as a whole for analysis. Results show that a protection strategy of hardening a few critical components is also good strategy for the combined system. In addition, the findings and several assumptions are further discussed to close the gap between theory and practice.

Key words: complementary transportation systems; vulnerability analysis; complementary strength; critical components; railway system; airline system;

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