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Assessing the Resilience of Urban Metro Stations Under Large-Scale Sporting Events Using Smart Card Data: A Case Study in Seoul

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Abstract

Large-scale sporting events generate a sudden surge in passenger demand at metro stations immediately after the event, resulting in platform queue accumulation and congestion propagation throughout the metro network due to limited train carrying capacity. This study develops a queueing theory-based simulation framework using smart card data for Seoul Metro Line 6 and quantitatively evaluates station-level congestion resilience based on system performance. Based on the temporal system performance curve, four resilience indicators—Vulnerability, Adaptability, Robustness, and Recoverability—are derived to assess the resilience of individual stations. The results indicate that event-induced congestion is not confined to the World Cup Stadium Station but propagates sequentially to adjacent stations and toward the downtown area, with several downstream stations experiencing greater resilience losses than the event station itself. The proposed framework provides a quantitative approach for evaluating the occurrence, propagation, and recovery of metro congestion from a resilience perspective. It provides practical insights for developing operational strategies to manage large-scale sporting events.

Biography

Euntak Lee is an assistant professor in the Division of Smart Cities at Korea University, Sejong, South Korea. He received his Ph.D. in Urban Planning and Engineering from Yonsei University in 2023. Prior to joining Korea University, Dr. Lee held postdoctoral research positions at the Gustave Eiffel University, Lyon, France. His research focuses on transportation engineering, intelligent transportation systems, autonomous vehicles, and digital twins. His research group studies autonomous vehicle takeover control for older drivers and digital twin-based real-time traffic optimization and management system for transportation policy decision support.