

# Optimizing Railway Network Capacity: Analytical Approaches and Case Study Insights

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**Abstract.** Railway capacity optimization is essential for efficient and sustainable transportation. Optimization strategies help maximize the use of existing infrastructure, reducing the need for costly expansions and minimizing environmental impact. By enhancing train scheduling, signaling systems, and operational policies, rail networks can accommodate more traffic with fewer delays, improving overall service reliability. This paper examines key factors influencing railway capacity, including headway time, block section length, signaling systems, and operational speeds. Various analytical models and methodologies for capacity estimation are discussed. This paper uses the UIC's approach because it provides a clear and practical method for improving the performance of rail networks. The UIC's focus on international standards and cooperation helped to build a strong foundation for understanding capacity problems and suggesting effective solutions. It is utilized Along with a case study on the Egyptian National Railways (ENR) network. The results show that railway capacity is significantly influenced by signaling systems, train speed, block length, and braking performance. Optimizing these factors—by reducing headway, improving speed within policy limits, shortening block lengths, and enhancing braking systems—can lead to substantial increases in overall line capacity.

**Keywords.** Railway capacity, headway time performance, UIC Code 406, capacity assessment

