

# Development of Comprehensive Roadmap and Resource Guide Towards Congestion Reduction

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## BACKGROUND AND OBJECTIVES

Traffic congestion has become an increasingly critical issue across the United States, disrupting transportation networks and impacting society in ways that extend beyond mobility. Congestion contributes to declining public health, reduced quality of life, and environmental concerns such as pollution, noise, and stress (Meyer, 1997). Nationally, travel delays rose from 5.1 billion hours in 2000 to 8.7 billion hours in 2019, while fuel waste increased from 2.4 billion gallons to 3.5 billion gallons over the same period. Similarly, excess greenhouse gas emissions escalated from 25 million tons to 36 million tons, and the total economic cost of congestion more than doubled, surging from \$77 billion to \$190 billion. Truck congestion costs also grew significantly, rising from \$7 billion to \$20 billion. While these figures temporarily declined in 2020 due to COVID-19 lockdowns and restrictions, data indicates a rebound by the end of the year (Schrang et al., 2021). Furthermore, congestion patterns vary by roadway type, geographic location, and time of day, with cities, counties, and metropolitan areas experiencing different levels of congestion.

Despite the availability of various congestion mitigation strategies, a comprehensive roadmap for reducing congestion has been lacking. The objectives of this research aimed to gather the information and practices on 12 identified key congestion mitigation areas, develop congestion reduction roadmap supplemented with a resource guide, and provide state DOTs, local transportation agencies, and MPOs with a vision and actionable steps towards congestion reduction. These 12 areas include (1) Smart and Advanced Signal Timing and Optimization Systems, (2) Traffic Incident Management, (3) Transportation Systems Management and Operations (TSM&O) Strategies, (4) Multimodal Transportation, (5) Shared Transport Systems, (6) Telecommuting and Flexible Work Hours, (7) Smart Navigation Systems, (8) Public Transportation Systems, (9) Congestion and Road Pricing, (10) Connected and Automated Vehicles, (11) Advanced Transportation Technologies, and (12) Other Emerging Technologies. The proposed roadmap offers a structured framework with clear steps to tackle congestion in all metropolitan areas.

## METHODOLOGY

The development of the congestion reduction roadmap was guided by a comprehensive mixed-methods research approach, integrating literature summary and insights from national and international transportation professionals and researchers. The process began with an extensive literature review to assess existing congestion mitigation strategies and their effectiveness. This was followed by 37 in-depth interviews with industry experts, which provided valuable firsthand perspectives on best practices, challenges, and emerging trends. By examining the 12 distinct congestion reduction strategies, the study identified successful case studies and key lessons learned, which informed the roadmap's structure. The strategies were further analyzed based on their suitability for different metropolitan area sizes and their expected implementation timeline (short-term vs. long-term). Given the rapid advancements in transportation technology, it was recognized that emerging and advanced solutions would likely yield their full benefits over a longer timeframe. To enhance decision-making, a rating system was applied to evaluate the effectiveness of each strategy, ensuring that recommendations were both practical and scalable for cities of varying sizes.

Through a systematic review of research and expert insights, this study provided a holistic understanding of congestion reduction methods, their potential impacts, and their feasibility under different urban conditions. The evaluation of current and future technologies shed light on their benefits, limitations, and interconnections, helping to identify the most effective approaches for sustainable congestion management. The resulting roadmap serves as a strategic, actionable guide for practitioners, policymakers, and researchers, equipping them with the necessary tools to address congestion challenges efficiently and effectively. By incorporating both proven solutions and forward-looking innovations, this research offers a comprehensive framework to enhance mobility, reduce environmental impacts, and improve overall transportation system performance.

## RESEARCH FINDINGS

The 12 major congestion mitigation areas offer a diverse range of solutions to reduce or manage traffic congestion, each playing a distinct role or complementing one another when combined. While some strategies are particularly effective for addressing recurring congestion, such as daily traffic bottlenecks, others are better suited for non-recurring congestion, caused by incidents like crashes or roadwork. The effectiveness of each approach also varies by metropolitan area size—some solutions are more applicable to very large and large urban areas, while others work best in medium and small urban settings. However, certain strategies, particularly those leveraging existing and emerging technologies, show universal effectiveness, providing benefits across different contexts and congestion types. These technological solutions are expected to become even more impactful in the future as advancements continue. Each mitigation area comes with its own set of benefits, limitations, and uncertainties, and while some strategies are more closely interconnected than others, all contribute to a comprehensive congestion management framework. Additionally, documented successful case studies and lessons learned offer valuable practical insights to guide effective implementation.

In some cases, reducing traffic congestion should not be the primary goal, as congestion itself can serve as an incentive for travelers to explore alternative transportation modes. Increased congestion can make public transit, cycling, and walking more attractive and competitive, encouraging a shift away from private vehicle use. In large and very large urban areas, a more sustainable and impactful approach involves prioritizing public transportation and multimodal solutions, such as expanding bus, train, and ferry networks, as well as shared mobility options. Investments in multimodal infrastructure not only mitigate congestion but also foster economic development, environmental benefits, and improved urban mobility.

Reducing traffic congestion remains a persistent challenge as long as private vehicles continue to dominate urban transportation. Expanding and improving the accessibility of alternative transportation options is essential for fostering long-term progress. In smaller and mid-sized cities, the implementation of smart and advanced traffic signal timing has proven particularly effective in enhancing traffic flow. In larger urban areas, however, optimizing traffic signals alone is not enough. Key strategies include incident management, Transportation Systems Management and Operations (TSM&O), robust public transportation networks, multimodal options, telecommuting, and flexible work policies—all of which have consistently proven effective in mitigating congestion.

A truly effective strategy for mitigating congestion requires a comprehensive, context-specific approach that addresses both recurring and non-recurring challenges. Core strategies involve deploying advanced traffic signal systems to optimize flow, adopting TSM&O practices to enhance efficiency, and developing robust incident management plans to minimize delays from unexpected disruptions. Equally important is promoting multimodal transportation by integrating public transit, cycling, walking, and shared mobility options to create a balanced, accessible network. By combining these approaches, cities can improve mobility, enhance sustainability, and reduce the economic and environmental burdens of congestion, fostering a more resilient urban transportation system.

## POLICY AND PRACTICE RECOMMENDATIONS

To effectively manage congestion, cities must go beyond vehicle-focused solutions and integrate land-use planning. Instead of solely expanding road capacity, policies should promote mixed-use development that places essential services closer to residential areas. Creating walkable, transit-friendly communities reduces long commutes and car dependency, improving mobility and sustainability.

A multimodal approach is key to congestion management. Cities should implement advanced traffic signal systems, adopt TSM&O strategies, and develop incident management plans to address congestion hotspots. Expanding public transit, cycling infrastructure, and shared mobility options provides residents with viable alternatives to driving, reducing travel delays and environmental impact.

In large cities with strong transit networks, dynamic toll roads and congestion pricing can help manage traffic, boost transit reliability, and fund improvements. Investing in walkable infrastructure, cycling lanes, and smart mobility supports sustainable growth. These strategies reduce congestion, enhance air quality, and create efficient, accessible, and eco-friendly urban transportation systems.

While emerging technologies like automated vehicles, smart navigation, connected systems, and urban air mobility may not provide immediate relief, they offer mid- and long-term potential for congestion reduction and safety improvements. Strategic planning for these innovations will be essential in shaping future mobility solutions.

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