# Decision Support for Traffic Management Systems

*Research and Development*

FACT SHEET

Traffic management systems (TMSs) are complex operational systems. TMSs enable human operators to facilitate improvements in the efficiency, safety, and predictability of travel on the surface transportation system. As shown in figure 1, TMSs combine field equipment, information technology and communications, software, and other tools to collect and synthesize traffic data, integrate external systems, and enable command and control of intelligent transportation system field devices.

Traffic management relies on timely decisionmaking in support of monitoring traffic conditions, detecting and managing unplanned events, scheduling and managing planned events, improving traffic signal timing, assessing



**Figure 1. Photo. A traffic operations center in Chester, VA.**

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and planning for adverse weather, and managing critical infrastructure. The management and operation of TMSs rely on an agency expert's decisionmaking, which involves unique knowledge, skills, and experience. Improving the timeliness and effectiveness of decisionmaking is a focus for agencies exploring opportunities to improve how they manage and operate TMSs, and improve safety and travel.

## Decision-Support Tools

Computer- and noncomputer-based decision-support tools (DSTs) support a range of decisions. Noncomputer-based DSTs are paper-based (e.g., incident response plans and decision trees) that can be printed and collated into references or tools. Computer-based DSTs are based online and provide real-time information (e.g., traffic analyses and lookup tables). Computer-based DSTs can potentially play a key role in improving the real-time decisionmaking of traffic operations personnel by complementing and enhancing the operational capabilities of TMSs.

DSTs can aid operations personnel in monitoring and assessing conditions (e.g., environmental factors, transportation facilities, or transportation networks), detecting and verifying adverse conditions, and identifying and evaluating appropriate response strategies to planned and unplanned events. DSTs can also help agencies achieve more consistent and

understandable decisionmaking across their transportation management staff. Within a TMS, computer-based DSTs may process vast amounts of data, capture the operational processes of an agency, and potentially mimic the real-time decisionmaking of TMS operators.

## Types of DSTs

There are three common types of DSTs that are useful for traffic management:

### 💡 Knowledge-Driven Tools

Seek to generate a decision or recommendation by emulating reasoning and decisionmaking behavior. These DSTs process facts and business rules instead of data and are known as "rules-based systems" or "expert systems."

### 🗄 Data-Driven Tools

Enable the process, manipulation, and visualization of large amounts of data to derive business insights that support decisionmaking. Business intelligence tools and artificial intelligence (or
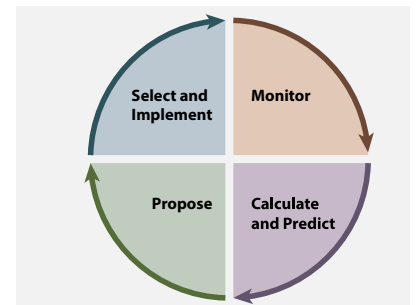


Source: FHWA.[2]

**Figure 2. Illustration. Traffic management decisionmaking.**

machine-learning technologies) are the most common types of data-driven DSTs.

### 📊 Model-Driven Tools

Incorporate complex mathematical models to derive insights and provide forecasting and predictions using simulations, optimizations, and statistics.

## Why Use DSTs?

Decisionmaking is an inherently complex process (figure 2), and the challenges it presents may be compounded by additional factors,

including the experience level of decisionmakers as well as societal pressures, cultural norms, fatigue, inherent biases, and other limitations decisionmakers may face. These factors also impact the quality of the policies, procedures, programs, actions, services, or operational performance that result from the decisionmakers' conclusions. These limitations and biases become more pronounced when systems grow in complexity, decisions need to be made quickly, or there is either insufficient data or time to assess an incomprehensible amount of data.

DSTs can be valuable assets to an operator in a TMS. As the management and operation of the surface transportation system grows more complex and congested, DSTs are designed to optimize the safety and efficiency of the movement of people and goods.

Improving the responsiveness, timeliness, and effectiveness of real-time decisionmaking is a central focus for agencies that manage and operate TMSs. Decisionmaking relies on having a strong knowledge of the surface transportation system, understanding agency policies and operational procedures, and processing and assimilating a wide range of data and information.

## Choosing DSTs

DSTs used within a TMS can be characterized by the type of interaction and the approach used in the tool. The type of interaction refers to the level of human interaction with the DST—how decisions are made (manually or automatically), and the degree to which the DST involves the decisionmaker (interactive or automated).

Online and offline DSTs can both support the management and operation of TMSs. Offline DSTs are typically used to support policy-related, short-term or long-term planning, programming, or scenario-based testing activities. Online DSTs include computer-based software tools incorporated into the real-time decisionmaking involved with actively managing and operating TMSs.

## Incorporating DSTs into TMSs

One of the objectives of integrating a DST into a TMS is to automate or support the decisionmaking required by operators or a TMS. A DST integrated into a TMS requires an interface, procedures, and/or resources to assist an operator or analyst using the tool. The DST (and/or its software) may need to be integrated with the software subsystem and software programs, data subsystem, and computing hardware. This integration allows DSTs to use data (e.g., translated into appropriate formats), make the necessary decisions, and include these decisions in the interface used by operators to manage and operate a TMS.

### DSTs

DSTs benefit TMSs by providing agencies with the ability to make fast decisions, automate parts of the decisionmaking process, and provide a higher level of safety. The following show the major benefits of using DSTs:

- Ensure consideration of alternatives.
- Minimize the influence of biases (e.g., confirmation bias) on decisions.
- Encourage quantitative assessment of options.

## Resources

1. Virginia Department of Transportation, 2018. "RTS _3767 Traffic Operations Center, Chester, VA. CRO" (web page). https://www.flickr.com/photos/vadot/44536652080, last accessed February 1, 2023. This website shows a photo of the Virginia Department of Transportation's Traffic Operations Center in Chester.

2. Miller, K., J. Horner, J. Adler, and R. Sanchez. 2021. *Decision Support for Traffic Management System–Current Practices*. Report No. FHWA-HRT-21-108. Washington, DC: Federal Highway Administration. https://www.fhwa.dot.gov/publications/research/operations/21108/21108.pdf, last accessed January 20, 2023. This report provides an overview of DST practices and technologies. This report highlights the key issues and current practices agencies have been using when selecting and integrating DSTs into a TMS.

3. Miller, K., J. Horner, J. Adler, and R. Sanchez. Forthcoming. *Decision Support for Traffic Management Systems Report*. Washington, DC: Federal Highway Administration. This report provides an overview of technologies and processes when selecting and integrating a DST into a TMS. The report also highlights the stages of decisionmaking that agencies can use to evaluate, plan, design, develop, and deploy a DST.

http://safety.fhwa.dot.gov

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