MISSOURI DEPARTMENT OF TRANSPORTATION

TSMO Informational Memoranda

August 2023

MISSOURI DEPARTMENT OF TRANSPORTATION

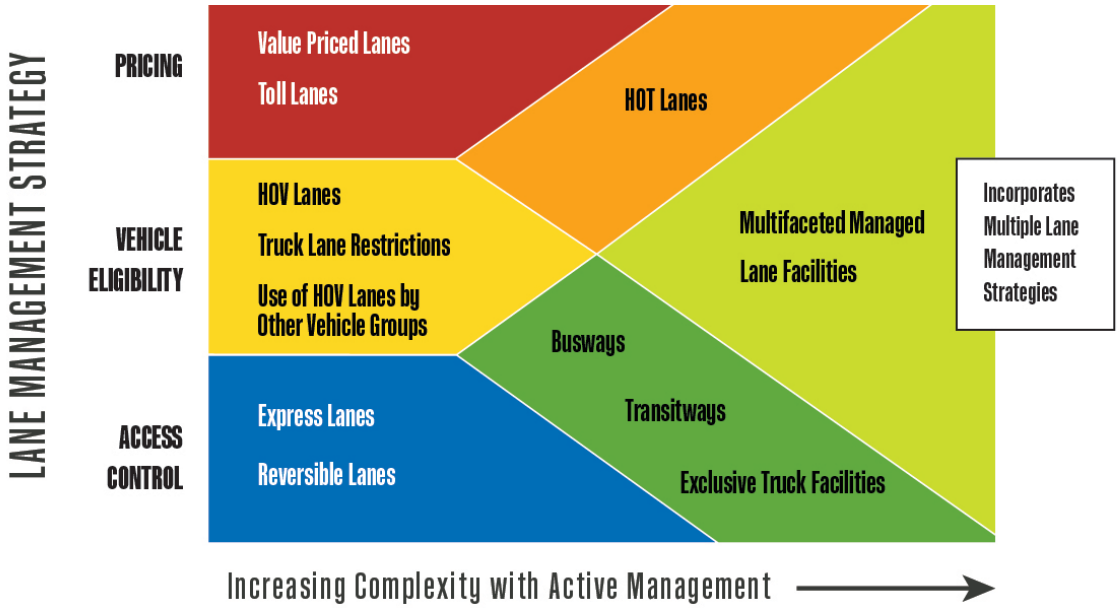
TSMO MEMO

TABLE OF CONTENTS

MANAGED LANES

The number of Vehicles Miles Traveled has increased significantly (more than 70%) in the last 20 years whereas highway capacity has only grown by 0.3 %. As a result, agencies are seeking ways to better manage traffic flow on existing infrastructure. Typically, this has been done by employing lane management strategies that regulate demand, separate traffic streams to reduce turbulence, and utilize available and unused capacity.

Definition



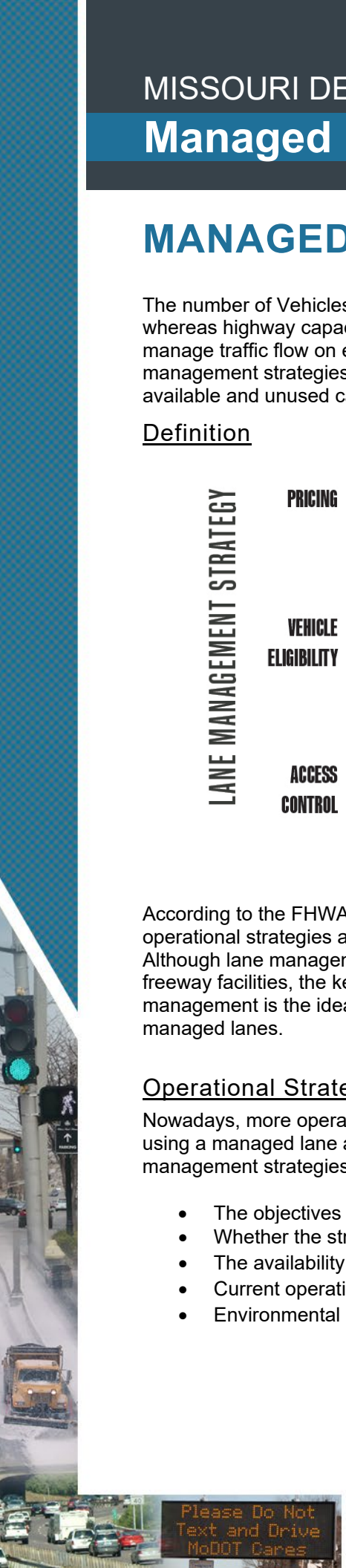
According to the FHWA Managed lanes are defined as highway facilities or a set of lanes where operational strategies are proactively implemented and managed in response to changing conditions. Although lane management strategies have been used by agencies for decades to improve flow on freeway facilities, the key difference between managed lanes and other traditional forms of freeway lane management is the idea of “active management.” Figure 1 shows the different applications of the managed lanes.

Figure 1: Managed Lane Applications[1]

Operational Strategies

Nowadays, more operating agencies proactively manage demand and available capacity on the facility using a managed lane approach by applying new strategies or modifying existing strategies. The lane management strategies employed vary depending on:

- The objectives of the project
- Whether the strategy is implemented on a new capacity or an existing facility
- The availability of right-of-way
- Current operational characteristics in the corridor
- Environmental and societal concerns



Managed Lanes

The operational strategies for managed lanes can be categorized into three categories – pricing, vehicle eligibility, and access control. Each of these three categories is reviewed below from the perspective of how lane management strategies are analyzed and selected.

Pricing

Pricing has been employed as a lane management strategy to manage demand and to make use of underutilized capacity. Value pricing is the nationally recognized term currently applied to a system of fees or tolls that vary according to the level of congestion on a roadway facility. Higher tolls are usually charged when congestion is heaviest and delay is at its worst. Of the three types of lane management strategies, only pricing has demonstrated in practice that it offers real-time active management capabilities.

Vehicle Eligibility

Vehicle eligibility restricts use of certain lanes by type of vehicle, as in HOV lanes. It is a valuable tool in managing demand while meeting policy objectives. Vehicle eligibility may vary by time of day, day of the week, and may change over the life of the facility as conditions change. Vehicle eligibility has not been used to regulate traffic flow on a dynamic basis, like pricing.

Access Control

Access control is used to limit entry to a facility based upon congestion levels or operational conditions, such as post-crash or maintenance needs. Access is not necessarily restricted by the type of user, although it may be in situations where direct connect ramps are provided exclusively for bus or carpool use. Demand can be managed by limiting access to fewer entry and exit points, using grade-separated ramps as opposed to at-grade ramps, or utilizing actual barriers at ramp locations to control access.

Success Stories

The success of a managed lanes project will depend on the effectiveness of the operating strategy to address these characteristics. Careful forethought of project goals is critical to choosing the most appropriate management techniques to implement on the facility. The studies presented in this document incorporate all three forms of lane management: pricing, vehicle eligibility, and access control.

Project Goal	*Location*	*Operational Strategies*
Utilize available HOV capacity while preserving bus operating speeds	QuickRide – Houston, Texas	Heavy Occupancy Toll Lanes, Reversible Single Lane, Peak Hour Operation
To relieve the traffic congestion, add travel choices, improve travel reliability, and enhance safety	I-495 – Washington, DC & Virginia	Express lanes, High Occupancy Toll Lanes, Reversible flow lanes
To communicate travel times, traffic incident information, lane closures and traffic pattern changes	Between Barrington Road and the Kennedy Expressway on I-90, Illinois	Road signs, Traffic Sensors, Flex Lanes
To relieve the traffic congestion (recently approved)	US-69, Overland Park, KS (*recently approved*)	Express toll lanes
To improve travel time and relieve congestion	Dodge Street – Omaha, Nebraska	Access control, express lane

Managed Lanes

Best Practices

The managed lane projects in operation today use a combination of strategies and have common characteristics that have led to their success. These best practices focus on three key areas:

- Planning and project development
- Facility monitoring and evaluation
- Life-cycle considerations

Planning and Project Development

The planning and project development phase for any managed lane strategy consists of the following steps:

- **Agency collaboration** - The most successful projects have been cooperative efforts of various agencies, from the initial stages of project development through operations. Planning for managed lanes projects may require input from federal agencies, the state department of transportation, the metropolitan planning organization, and other local agencies.
- **Selecting a managed lane strategy** - The lane management strategies may vary depending on the objectives of the project, whether the strategy is implemented on a new or existing facility, the availability of right-of-way, current operational characteristics in the corridor, and environmental and societal concerns.
- **Identifying a hierarchy of users** - An operating agency should define its higher priority users and lower priority users. Lower priority users will experience the impact of increased prices and/or restricted access as strategies are applied to manage demand.
- **Establishing threshold values** - Threshold values could be based on traffic volumes, operating speed, or similar measures. When the threshold value is exceeded, it triggers an action to modify the lane management strategies to maintain operating objectives.
- **Communicating the strategy** - It may be very easy for transportation professionals to understand the benefits of a managed lanes project that involves pricing. On the other hand, politicians and the public may look at pricing as an unfair imposition. Public education and outreach have been critical to the success of operating projects.

Facility Monitoring and Evaluation

Successful implementation of any strategy involves constant monitoring and assessments. There are two aspects that come under this:

- **Project Flexibility** - It is important to note that successful projects have the flexibility to alter operations as conditions warrant and priorities change.
- **Monitoring and Evaluation** - Under the principle of active management, the need for continual monitoring and evaluation of the managed lanes is imperative. At the outset of a project, specific performance measures and threshold values are defined, and those measures should be continually evaluated.

Life Cycle Considerations

Given a flexible, actively managed facility, the agencies need to consider the expectations of its performance and mobility contribution over the full life of the project. This notion takes agencies beyond the day-to-day adjustments in price to a thoughtful plan of facility changes triggered by pre-established performance measures. An example of such considerations is shown in the figure below:

Managed Lanes

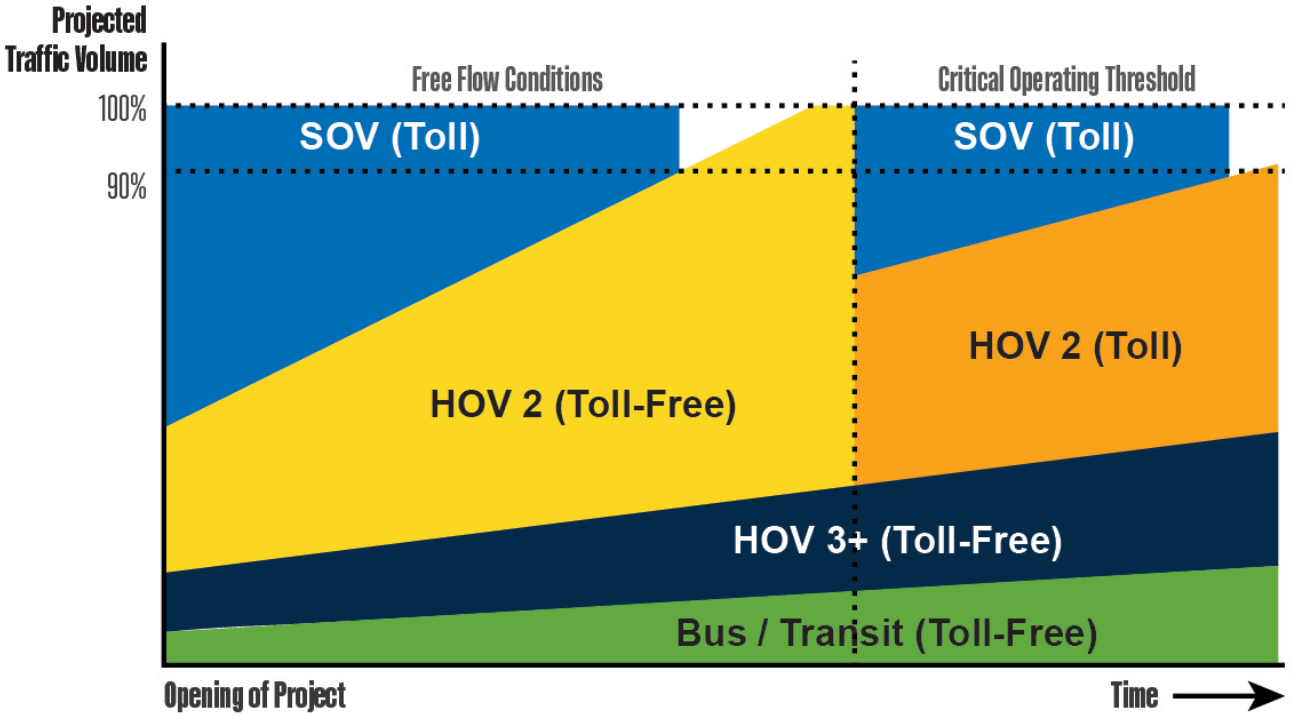


Figure 2: Example of the Lifespan of a Managed Lane[1]

This section highlights the key areas that need consideration while dealing with Managed Lanes.

- Managed lanes projects must have clear objectives and a vision of how to achieve the objectives in order to measure success.
- Managed lanes projects are often large undertakings that cross jurisdictional boundaries, making agency cooperation crucial. Institutional roles and responsibilities should be identified early in the planning process and documented with project agreements that define each agency's role in project implementation. The agreements should also provide flexibility for unforeseen circumstances.
- Managed lanes are a new and complex concept to most travelers. Public understanding and acceptance of a project are critical not only to individual projects but also to any expansion into a system. Political opposition and lack of public understanding sometimes end up killing a project.
- The public, as well as key officials, must understand the circumstances in which managed lanes may provide a workable solution to problems of congestion or other lane management needs.
- A thorough understanding of corridor characteristics is imperative to managed lane success. For pricing to be feasible, it must offer a service superior to the adjacent general-purpose lanes.
- Enforcement is paramount to protecting the integrity of a managed lane facility. Enforcement on facilities that use both pricing and vehicle eligibility has two compliance tasks: toll account verification and vehicle eligibility verification (usually based on occupancy).

Managed Lanes

Missouri has the nation's seventh-largest state highway system, one that carries residents and travelers more than 50 billion miles annually. High demand and lack of infrastructure have led to an increased burden on users due to increased crashes, congestion, fuel consumption, and vehicular wear and tear. By this measure, the costs imposed on travelers by condition shortfalls has been increasing and adds up to about $172 per month—costs that could be reduced by improving system conditions. The existing state of managed lanes in Missouri is discussed briefly below:

- **Toll Roads** - The state of Missouri does not have a state-sponsored toll road system. Although the statutes allow for local political subdivisions to build toll bridges and toll roads under certain circumstances, the Missouri Department of Transportation does not have the authority to engage in building toll roads on its own which makes the enforcement of pricing strategies next to impossible. Moreover, Federal law prohibits tolls on any existing interstates.
- **Reversible lanes/Express Lanes**- A reversible lane or roadway is one in which traffic may travel in either direction, depending on certain conditions. The only reversible lane in Missouri is on I-70 in the City of St. Louis. Due to a lack of resources, it has not been used for management purposes in a while.
- **High Occupancy Vehicle (HOV) Lanes** - The Missouri Highways and Transportation Commission is authorized to designate lanes on state highways as high occupancy vehicle lanes. However, no existing general-purpose lanes may be so designated.

Future of Managed Lanes

Managed lanes consist of a wide number and array of infrastructure improvements, technological improvements, and pricing strategies with the overall objective of improving travel flow. Where implemented, managed lanes have been shown to improve travel times and traffic flows, reduce the economic costs associated with congestion, reduce fuel consumption, and improve air quality through reductions in vehicular emissions. They can also achieve these benefits at a lower cost than other transportation improvements. The study has highlighted successful practices in operation today. However, there are still emerging issues and research gaps. These issues should be explored so that specific tools, techniques, and strategies can be developed that will ensure the successful implementation of future managed lane projects.

Managed Lanes

References:

1. FHWA – Managed Lanes – A cross-cutting study.
2. Illinois – Smart Road on I-90
3. Virginia – I-495 Southside Express Lanes Study
4. Missouri – 21st Century Missouri Transportation System Task Force

SPEEDING MITIGATION

Speeding is a factor in about 12% of all crashes and over 25% of fatal crashes in the US. Although the number of speeding-related fatalities in 2019 decreased by 1 percent from 2018, the United States has seen more progress in other major safety issues, such as seat belt use and impaired driving, while little has improved with speeding.

Definition

According to the FHWA, speeding is defined as exceeding posted speed limits or driving too fast for conditions[1]. This is an aggressive driving behavior that some engage in without recognizing the risks or seriously considering the consequences.

Why Does it Happen?

The National Highway Traffic Safety Administration (NHTSA) suggests that several factors contribute to a rise in aggressive driving behaviors:

- Traffic congestion
- Running late
- Drivers feeling anonymous within their car
- Disregard for others and for the law

How is it Negatively Impacting Traffic?

According to NHTSA, 28 percent of fatal crashes, 13 percent of injury crashes, and 10 percent of property-damage-only crashes in 2020 were speeding-related.
The consequences of excessive speed include:

- Greater potential for loss of vehicle control, which may result in a crash
- Reduced effectiveness of occupant protection equipment
- Increased stopping distance after the driver perceives a danger
- Increased degree of crash severity leading to more fatalities and disabling injuries
- Unexpected economic and even psychological implications of a speed-related crash
- Increased fuel consumption and cost

What is the Cost of Speeding?

The NHTSA estimates that the economic cost of speed-related crashes is about $52 billion in the United States each year. In Missouri, all crashes are estimated to cost the state $5.56 billion per year and speed-related crashes specifically are estimated to cost $667 million[2].

Speeding Mitigation

In Missouri…

Local Concerns

Adjusting speed limits in Missouri can be challenging. If a local agency has passed an ordinance establishing an inappropriate speed limit, MoDOT district staff must conduct a traffic engineering study using MoDOT's Speed Study Analysis Template to determine the appropriate speed limit and confer with the agency. If the agency and the MoDOT staff cannot reach an agreement, the situation will be escalated to the Missouri Highways and Transportation Commission, which will conduct a review of the study and make a determination. If necessary, the agency may need to adjudicate all enforcement through state courts until they pass a new ordinance specifying the speed limit is the same as posted.

This is particularly noticeable in small towns in Missouri. As the towns expand geographically, the speed limit tapers approaching the towns need to be shifted. Frequently, this does not happen due to the time required and the difficulty of the process. This results in vehicles travelling too fast for conditions, even if they are following the posted speed limits.

State Law

Maximum allowable speed limits are set by 304.010 of the Revised Statues of Missouri. There was a bill introduced in May 2022 to amend 304.010, reducing the speed limit on unmarked roads from 50 to 40, but it was rejected.
In Missouri, driving between 5 and 20 mph over the speed limit is a Class C misdemeanor. Driving more than 20 mph over the speed limit is a Class B misdemeanor.

Speed Limits

The Missouri EPG section 905.2.14 provides guidelines for determining appropriate speed limits and for changing speed limits. EPG Section 905.2.14.2 offers the guidance for selecting a speed limit based on the prevailing speed. Sections 905.2.14.2.1-5 suggests reductions to the base speed according to crash rate, pedestrian traffic, adjacent parking, and adjacent developments.

Speeding Mitigation

Speeding Mitigation Strategies

The following table includes several strategies that have been shown to be effective in reducing speeds. Each strategy varies in application, cost, and impact duration. Messaging and design considerations are typically considered to be the most effective tools for reducing speeds. Additional detail on each of these strategies can be found in the EPG.

Strategy	*Application*	*Notes*
Design Considerations		
Roundabouts	Any road type	85th-percentile entry speeds between 13 and 17 mph[4]
Chicanes/reverse curves	Local roads or minor arterials	
Speed bumps, humps, tables	Local roads or minor arterials	Speed tables have an 85th-percentile speed of 25 to 30 mph[5]
Narrow Lanes	Local roads	Reduce mid-block speeds on four-lane arterials, reduce driver comfort on higher-speed facilities[6]
Rumble strips		Transverse rumble strips show a mean speed reduction of 1.3 mph[7] No documentation on longitudinal rumble strips
Messaging		
DMS	High speed roads	
Dynamic curve warning signs	High speed roads with significant horizontal curvature	Reduce speeds when drivers have exceeded the maximum safe speed[8]
Flashing school zone signs	School zones	
Speed Trailers	Work zones, any road type	Reduce mean vehicle speeds by 1.4 to 4 mph within work zones[9]
Variable Speed Limit (VSL) Systems	Generally on freeways and highways	Some states indicate a reduction of speed approaching work zones or during adverse weather conditions[10]
Enforcement		
Law Enforcement	Any road type	

Design Considerations

Roundabouts and chicanes or reverse curves cause interruptions in straight, flat travelways, which require additional attention from drivers and reduce the perceived safe speed. EPG section 233.3 governs roundabouts.
Speed bumps can cause issues with snow removal.
Narrower streets, especially in residential areas, discourage high speeds.
Rumble strips are not designed as a speed control device, but do show reduced speed where used.

Messaging

Dynamic messaging signs are not typically used to display speed limits, but can alert drivers to unusual conditions which may require different speeds. EPG section 910.3 contains information about DMS.
Dynamic curve warning signs alert drivers and allow an opportunity to achieve safe speeds before a curve.

Speeding Mitigation

Flashing school zone signs are shown to reduce speeds, but they have limited applicability. EPG section 902.12 discusses application of flashing beacons.
Speed Trailers provide input from outside the vehicle, which could encourage drivers to monitor their speeds.
Variable Speed Limit (VSL) Systems reduce speeds so that human injury tolerances are accommodated in three ways: improving visibility, providing additional time for drivers to stop, and reducing impact forces.

Enforcement

Fear of receiving an infraction from law enforcement could cause drivers to reduce speeds. These benefits are generally temporary.

Future of Speed Control

We anticipate that additional technologies and strategies will continue to emerge. MoDOT TSMO staff throughout the organization will continue to monitor, evaluate, and recommend these strategies as needed.
Known technologies expected to have a significant impact on speeding are Connected and Automated Vehicles (CAV). Connected Vehicle technology, for example, can provide additional warnings about impending conflicts. Automated Vehicle technology can provide additional benefits because a vehicle driving itself will not exceed a dictated maximum speed. As more and more of these vehicles enter the mix, their impact will be to reduce the overall speed of the entire vehicle fleet.

References:

1. FHWA – Traffic Safety Facts – 2019 Data
2. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812013.pdf
3. https://nacto.org/docs/usdg/nchrp613_ray.pdf
4. https://nacto.org/docs/usdg/nchrprpt572.pdf
5. https://safety.fhwa.dot.gov/saferjourney1/library/pdf/toolsintro.pdf
6. https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=826
7. https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=828
8. https://trid.trb.org/view/702058
9. https://intrans.iastate.edu/app/uploads/2018/03/workzone.pdf
10. https://www.transportationops.org/publications/synthesis-variable-speed-limit-signs

TRAVELER INFORMATION

In a highly mobile and connected society, travelers have a need for accurate and timely information to help them reach their chosen destinations safely and efficiently. Providing this information may help influence drivers' route choice, speed, and travel time expectations.

Definition

Traveler information is any trip-related information provided to an active or potential traveler. Information can include traffic conditions, the availability and conditions of public transportation, and the availability of parking, for example. Advanced traveler information systems use technologies that assemble and process near real-time travel-related data and disseminate useful information to travelers via push technologies or make the information available on a website. Traveler information systems may cover a single metropolitan area, an entire state, or a larger area such as a multi-state corridor.

Existing Traveler Information Resources

Traveler Information in Missouri

MoDOT and its three Transportation Management Centers (TMCs) each support a web-based traveler information system. The websites have been developed specifically for each system.

- **Statewide** MoDOT Traveler Information website (https://traveler.modot.org/map/index.html) consists of a desktop website and mobile application.
- **Gateway Guide** in the St. Louis district (https://www.gatewayguide.com//) has a desktop website.
- **KC Scout** in the Kansas City district (http://www.kcscout.net/) has a desktop website, a mobile website, and a mobile app.
- **Ozarks Traffic** in the Springfield district (https://www.ozarkstraffic.com/) runs a desktop and mobile website.

Each of these traveler information sites contains similar information: traffic incidents, flooding, work zones, planned events, winter weather road conditions, real-time traffic speeds/congestion, cameras, message boards, and weather radar. MoDOT also maintains a separate website with oversize/overweight (OSOW) information relevant for commercial vehicles.

The 511 call system was established by federal administrators to provide voice based access to traveler information for anyone dials 5-1-1 on their telephone. It was originally intended to have nationwide coverage, hosted by each state. The advent of the smart phone, however, has nearly eliminated the public use of any existing 511 call systems. Missouri did not deploy a 511 phone system statewide, though it was briefly active in the St. Louis region.

Traveler Information in Neighboring States

Kansas, Iowa, and Nebraska use a commercially available traveler information system provided by Castle Rock Associates. This system has a toggle in the legend that offers a view for specific commercial vehicle that includes OSOW information, truck parking availability, and other relevant information specific to those travelers. Neighboring state websites also allow for fully customized views using selection options in the legend to turn information on or off. The traveler information websites for primary neighboring states can be found at: (https://www.511ia.org, https://www.kandrive.org/, https://www.idrivearkansas.com/, and https://www.gettingaroundillinois.com/).

Traveler Information

Community Feedback

Community outreach is important to understand the system usability and desired enhancements. There is a survey on the MoDOT statewide traveler information map where users can indicate what features they found useful or if anything was missing or hard to find. MoDOT reviews these responses periodically to identify issues and to prioritize enhancements.

Coordination with Outside Organizations

Traveler information is often provided to or received from to outside entities through data feeds or direct communication with the DOT. In Missouri, a few of these include the following:

Mapping Applications

Maps and navigation apps exchange information about crashes, work zones, road conditions, and real time traffic with traveler information systems. Digital information feeds like XML and GeoJSON feeds allow developers to directly import data that is relevant to their users. For example, Waze pulls incidents and road closures from feeds.

News Media

Local news outlets can reference traveler information systems to provide accurate reports of traffic conditions, crashes, and road work. Some states have created advertisements to draw users to their traveler information systems. For example, Florida ran a marketing campaign to increase awareness and usage of its 511 phone system and traveler information site – the campaign included a short public service announcement (PSA) video, local “meet and greet” events, media access to Florida Department of Transportation regional TMCs, and partnerships with JCDecaux and EyeCorp Media to place PSAs in airports and malls.[1]

Social Media

Social media platforms such as Twitter and Facebook allow agencies to publish information and connect with many travelers at a low investment cost. Comments, replies, and tags allow travelers to report conditions back to agencies, although this requires an employee to monitor for responses.

Emergency Alert Organizations

Local agencies, universities, and government institutions use systems like RAVE Mobile Safety to communicate emergency alerts, information about road closures and utility failures, and other operational updates to their communities.

Third Party Data Sources

Some data relevant received from outside sources is also provided as traveler information. Examples include:

National Weather Service – General weather information, radar, and severe weather alerts are offered as a layer for some traveler information websites. MoDOT Statewide and Gateway Guide both support a radar layer, while KC Scout and Ozarks Traffic do not have weather layers.

HERE – Probe data is provided through the company HERE. This data includes near real-time speeds and travel times, which can indicate areas of congestion to drivers.

Data Exchanges

Work Zone Data Exchange (WZDx) – USDOT established the WZDx as a common protocol for agencies to share and consume data about work zones. St. Charles County in the St. Louis area received a grant to develop this data feed, and MoDOT Statewide participation in WZDx is also underway. Data is being consumed by an increasing number of organizations as more and more states provide this data, which supports applications such as connected vehicles.

Changeable Message Signs and Dynamic Message Signs

Traveler information can be provided directly to travelers on the roadway through Dynamic Message Signs (DMS) and Changeable Message Signs (CMS). In Missouri, DMS are defined as permanent signs, and CMS are defined as portable. CMS and DMS message are actively posted by TMC operators.

Guidelines for when and how to use DMS messages are important to create consistent and effective messaging across districts, states, and regions. Current MoDOT guidelines for DMS are in EPG 910.3 and CMS are in EPG 616.6.60. In addition, the MUTCD provides national guidance for DMSs in Section 1A.15 and 2L.

Some regions are moving toward full color and full matrix DMS, which allow a greater variety of messages to be posted on signs. There is a University of Rhode Island study which indicates that drivers can comprehend and react 35% quicker to a DMS message that is supported graphically.[2]

Future of Traveler Info

Existing traveler information systems, like MoDOT's websites, may need to change as information delivery platforms evolve. MoDOT should balance the ability to develop its own product vs. other options for internal and external development, as well as "off-the-shelf" products. New methods and formats of exchanging data may emerge with the implementation of other advanced technologies like smart infrastructure.

The traveler information landscape will likely change with the adoption of connected and autonomous vehicles (CAV). CAV will allow vehicles to communicate regarding slow traffic conditions without needing external data like DMS, 511, or other traveler information systems. Connected and smart work zone devices can transmit data directly to vehicles (vehicle-to-infrastructure, V2I) and may even be able to change vehicle settings, like disabling cruise control, based on conditions. Signal Phasing and Timing (SPaT) data will be used in V2I applications to communicate signal timings directly to vehicles. These CAV applications may make DMS less necessary.

References

1. https://www.global-5.com/portfolio/florida511/
2. https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa09028/resources/Effect%20of%20DMS%20on%20Traffic.pdf