Technology-Based Transportation Vision

February 2022
**Background**

Pima County, like many large and growing communities in the West, has historically addressed transportation needs by building and widening arterial roadways to provide access to expanding residential development. The 1997 Highway User Revenue Fund Bond Program (HURF) was designed primarily to widen arterial roadways in Pima County that were over capacity due to years of development outpacing roadway infrastructure improvements. The 2006 Regional Transportation Authority (RTA) continues to fund roadway expansions and to a lesser extent, transit, as the principal mobility strategies.

Roadways have historically been widened to accommodate existing and future projected vehicular needs at peak travel times. However, design discussions have not considered whether the roadway supply is too large or whether alternatives to widening should be considered. Design criteria strive to support peak travel times resulting in costly infrastructure maintenance while the vast majority of the infrastructure remains underutilized the remainder of the day. This business model is unsustainable, yet as a community, we have subsidized this approach without question.

The American Society of Civil Engineer’s 2021 *Report Card for America’s Infrastructure* noted the cumulative investment needs based on current trends, 2020 to 2029, determined the investment gap is approximately $1.2 trillion for surface transportation. The City of Tucson estimates a need of $13.1 billion and based on that number, we can very roughly estimate at least an additional $7 billion needed for the rest of the region for a total exceeding $20 billion. Currently, the County is committing extremely limited financial resources towards addressing pavement maintenance by bringing all County roadways up to good or better condition by 2030. The success of this funding plan is dependent on limiting the scope of the program to pavement repair and preservation only, resulting in competing needs such as bridge repairs, shoulder stabilization and multimodal facilities being deferred.

In terms of safety, concerns and solutions have been historically identified through crash analyses at spot locations after the fact rather than through statistical analysis of network benefit. The current RTA allocates minimal funding for safety improvements and identifies intersection safety upgrades as the main safety improvement strategy. Yet a review for the unincorporated County shows that upgrading signalized intersections with the highest magnitude and severity of crashes relative to predicted performance, will only result in a predicted crash reduction for injury-related crashes of 3 percent network wide. Strategies generating better outcomes are imperative.

Despite the infrastructure and traffic control device investments made over the years, the number of fatalities has increased throughout the Pima County region for the past five years. According to the National Safety Council, motor vehicle deaths in 2020 are estimated to be the highest in 13 years despite the dramatic reduction in miles driven. Safety continues to degrade with roadway widening, as these project types facilitate higher speeds, create more conflict points, increase crossing distance, and induce vehicular demand, all of which can contribute to a greater number of crashes.


Challenges

Unincorporated Pima County is a geographically large area, representing many diverse communities and transportation needs. The diversity of the region requires the County to have the skills and equipment to maintain a variety of roadways and other assets from high-speed arterials to snow covered mountain roadways, and from sidewalks to rural dirt roads.

The County includes urbanized regions such as Flowing Wells and Drexel Heights, rapidly growing suburban communities such as Vail and Corona de Tucson, rural communities such as Picture Rocks, Ajo and Arivaca and the senior community of Green Valley. Each community has a distinct character with differing levels of access to transportation options and needs, as reflected by requests received from each. The County also includes five incorporated jurisdictions and two tribal regions that manage their own roadway networks. The traveling public rarely knows that they are crossing over these boundaries which creates challenges in the implementation of innovative solutions that can improve overall travel time and traveler experience. This diversity means that the County cannot prescribe a one size fits all policy or standard, but must tailor its response to the needs of the community and seek to be proactive rather than reactive.
The Pima County Department of Transportation (PCDOT) receives its funding for improvements, operations and maintenance through two main sources: state gas taxes collected within the Highway User Revenue Fund (HURF) and Transportation Vehicle License Taxes (VLT). In recent years there has been reliance on the General Fund (PAYGO) to support PCDOT’s pavement preservation and repair efforts due to the inadequacy of HURF and VLT. While VLT increases over time in proportion to the value of vehicles on the state’s roadways, an increase to HURF requires legislative change which has not occurred since 1991. During this period, the cost of building and maintaining the County roadway network has increased with inflation, while the revenue collected per vehicle has decreased as the fleet has become more fuel efficient. Because of these factors, the buying power of HURF revenue has decreased by 61% since 1991, causing funding shortfalls that inhibit the County’s capacity to provide services at the same level as has been provided historically.

**FY2021 Transportation Revenues**

- **42%** General Fund Transfer (Pavement Preservation and Repair)
- **41%** Highway User Revenue Funds (HURF)
- **15%** Vehicle License Tax (VLT)
- **1%** Permit Fees and Licenses
- **1%** Miscellaneous

*This funding shortfall has been a catalyst for Pima County to identify and evaluate new strategies, materials and technologies to provide and maintain a cost-effective and sustainable multimodal transportation system. This approach takes advantage of technological advancements to optimize current system performance, primarily focusing on utilizing existing infrastructure and thereby allowing PCDOT to implement both supply and demand-side solutions to complex transportation and mobility issues in a coordinated manner.*
Technology-Based Approach

Strategies to improve the transportation network and mobility to date, have focused on infrastructure modifications (supply-side strategies), and have largely ignored strategies that manage travelers or transportation demand. Limiting mobility mitigation strategies to only supply side investments exacerbates safety and ignores cost-effective and sustainable demand-side approaches that can be evaluated and implemented network-wide through modern technology. Using technology to manage traffic introduces a range of possibilities not harnessed or even imagined by many to date, with numerous implementation benefits. Managing demand by informing or incentivizing travelers away from peak travel times, trip sharing, travel pinch points and safer travel habits would negate the need to implement many costly supply-side solutions.

SUPPLY-SIDE SOLUTIONS

Traditional Infrastructure – Capital Improvement Program (CIP)

- Roadway Expansion or New Linkages
- New Intersection Control
- Multimodal Connectivity
- All-Weather Improvements

DEMAND-SIDE SOLUTIONS

Focus of Technology-Based Approach

- Adaptive Signals
- Distributed Routing
- Education
- Traffic Operations
- Ride Share

BENEFITS OF TRAVEL DEMAND MANAGEMENT STRATEGIES

- Regional Air Quality Improvement
- Regional Transportation Cost Reductions
- Traveler Safety Improvement
- Regional Fuel Consumption Reduction
- More Efficient Personal Travel Decisions
- Travel Time Reductions
- Maximizes Return on Infrastructure Spending
- Addresses Equity/Access to Transportation
These technology-based strategies can be best described through a Mobility on Demand (MOD) model. As defined by the United States Department of Transportation (USDOT), “MOD is an innovative, user-focused approach which leverages emerging mobility services, integrated transit networks and operations, real-time data, connected travelers, and cooperative Intelligent Transportation Systems (ITS) to allow for a more traveler-centric, transportation system-of-systems approach, providing improved mobility options to all travelers and users of the system in an efficient and safe manner.”

Figure 1 USDOT MOD Enablers

Pima County is utilizing the USDOT MOD Enablers, shown above in Figure 1, as the framework for the Technology-Based Transportation approach. A discussion of each of the framework elements and implementation examples for Pima County is in the following narrative. Automation and Emerging Technology is incorporated into the discussion of the remaining MOD Enablers.

Strategic Business Models and Partnering

Establishing a multidisciplinary team of experts provides for the greatest possible understanding of various mobility and crash factors and the relative effectiveness of mitigating strategies that are cost effective and sustainable. Team expertise includes human behavior, traffic engineering, road design, traffic analytics and enforcement.

PCDOT, Tucson Department of Transportation and Mobility (TDTM) and Marana Public Works Department have collaborated with the University of Arizona to form the Center for Applied Transportation Sciences (CATS). CATS is a transportation operations and research center focused on developing new tools and technologies to better manage the regional network. The Pima County region will utilize the research resources, knowledge and experience of the CATS team to advance technology-based transportation principles.

Policy and Practice

Exclusive focus on supply-side strategies to increase transportation system performance and enhance regional quality of life has not resulted in affordable or sustainable solutions. This focus has also exacerbated safety by prioritizing throughput capacity on arterial and collector roadways. Chuck Marohn describes the limitations of implementing these types of strategies in Confessions of a Recovering Engineer⁶, where he eloquently provides examples demonstrating that design standards, which prioritize “forgiving design” intended to reduce crashes, actually have the opposite effect, resulting in urban environment tragedy by prioritizing cross-town mobility within commercial areas, and draining wealth from communities due to the prohibitive cost of maintaining an oversized roadway network.

In order to enhance safety and quality of life while maintaining mobility, a shift in policies governing both infrastructure design as well as introducing demand management strategies is required. The first step in this process would be to reassess community values and mobility impediments independently of solutions. Once impediments and community transportation values have been determined and broken out in component parts, a range of solutions can be proposed to address these, including both supply and demand options. Mitigation strategies can then be evaluated in terms of return-on-investment with the highest performing ones meeting the representative value categories selected within the program fiscal constraints.

IMPLEMENTATION EXAMPLE

In lieu of the traditional approach of asking the community what infrastructure projects they would like to see, an alternative for implementation could be to pose a few questions such as:

- What do you perceive as the greatest impediments to current and future transportation safety and mobility?
- Where do you experience the greatest impediments in your travels within the region?
- How would you like your neighborhood to look?

These questions could identify the type of impediments experienced and life-style views envisioned which could be analyzed by the multidisciplinary team to propose a range of potential solutions to resolve the impediments and improve quality of life. Note that this is very different from asking people what they want, when they may not fully understand the range of options available.

To achieve this, the stated impediments could be broken out in their component parts such as supporting different modes (sidewalk needs to support pedestrians, shoulders or separated paths for cyclists, increased transit routes or frequency), safety strategies, freight reliability strategies, intersection and roadway delay relief, social equity, healthy strategies, climate change mitigation strategies, travel cost reduction strategies, etc. Once broken out, a range of strategies could be proposed and evaluated.

At a minimum, the benefit-cost of demand versus supply should be evaluated to provide the greatest constituent return-on-investment. Dynamic Traffic Assignment modeling can evaluate these options to feed return-on-investment determination.

Data Management and Urban Analytics

PCDOT is developing technologies and workflow processes that allow for real-time monitoring and data driven decision-making. These will be deployed to analyze and provide tools related to a variety of strategies, including the following:

- **Transit Management**
  - Transit service route, schedule and accessibility, and distribution of information to promote ridership

- **Carpool/Rideshare**
  - Connect people to minimize individual vehicular trips
<table>
<thead>
<tr>
<th>Incident Management</th>
<th>The efficient detection, response, and recovery from non-recurring events, and distribution of information to minimize the impact on traffic operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Management</td>
<td>Coordination of emergency response service providers; distribution of information and management of signal emergency preemption, flood control systems and road closures</td>
</tr>
<tr>
<td>Traveler Information</td>
<td>Trip and en-route information provided via in-vehicle or personal communication devices on the current travel conditions, special events, incidents, and work zones</td>
</tr>
<tr>
<td>Roadway Operations and Maintenance</td>
<td>Work zone and road closure management through the use of traveler data, lane and speed management systems, and coordination of enforcement and response service providers</td>
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<tr>
<td>Road Weather Management</td>
<td>Planning for and responding to weather events impacting traffic operations and roadway conditions, information distribution to travelers and response personnel and alternative route selection</td>
</tr>
<tr>
<td>Pedestrian Movements</td>
<td>Availability of pedestrian facilities within the transportation network to accommodate and promote non-motorized travel, and provide for first and last mile solutions</td>
</tr>
<tr>
<td>Alternative Work Schedules and Telecommuting</td>
<td>Work environment that supports employer-employee relationship from remote sites with consideration to accessibility, accountability, and productivity, options include four 10-hour days per week, staggered and flexible reporting hours and work from home</td>
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Figure 2 Transportation Demand Management Strategies

PCDOT has procured or has access to a variety of data and analysis systems which include:

**MIOVISION TRAFFIC INSIGHTS**

Intersection cameras and cloud-based analytic program that provides tools for signal optimization, intersection counts, performance measures, etc.

**STREETLIGHT DATA**

Cloud-based analytic program that provides origin-destination, Annual Average Daily Traffic (AADT), Annual Average Hourly Traffic (AAHT), and zone analysis utilizing location-based service and GPS data.

**INRIX**

Cloud-based tool providing congestion, traffic and bottleneck analysis, the County has limited access to data via the Arizona Department of Transportation’s (ADOT’s) contract.

**DynusT**

Dynamic traffic simulation and assignment software. As part of the partnership with the University of Arizona, a roadway network model has been built for the Pima County region. This model allows for scenario planning and evaluation of potential supply and demand solutions to address traffic congestion and capacity issues as described in a [September 2021 communication](https://miovision.com).
IMPLEMENTATION EXAMPLE

Pima County receives constituent requests for infrastructure and traffic control device modifications at spot locations throughout the network, such as the installation of an all-way stop or traffic signal. An analysis of an intersection could result in the prescriptive federal guidelines being met for signalization or all-way stop control based on the operational benefits at the isolated intersection. However, a network-wide benefit-cost evaluation through various data and analysis systems, such as a simulation through DynusT, should be conducted prior to determining if these types of traffic control devices are recommended. This allows the demand or supply-side strategy that provides the greatest return to be selected, which could result in no recommended changes to the location and system determined to be currently operating optimally.

Network-wide DynusT simulations can also be conducted for special events and road work to evaluate the effects of road closures and detours. Routing options can be reviewed to determine the network effects and most efficient alternatives for implementation. In addition, strategies for large scale special events could be evaluated, such as remote parking and transit to the venue, to reduce the congestion resulting from mass arrival and departure.

Mobile Technology and Payment Systems

Demand management strategies can be deployed through a contracted vendor platform providing routing, delay reduction options, rideshare and mode options, supplemented by locally pertinent functionality such as storm-related road closures, emergency and special event mobility mitigation and traveler coordination with signals and other intelligent infrastructure.

Through tools and incentives for individuals to make informed travel choices, traffic flow is managed and traveler behavior is influenced in real-time to achieve operational objectives, such as reducing fuel consumption, reducing travel time, improving safety, promoting sustainable travel modes, reducing emissions and maximizing system efficiency. Demand-side strategies provide individuals with enhanced travel choices such as travel route, travel mode, and trip departure time.

When fully developed and implemented, the County’s mobility platform will be a one-stop mobility application for complete trips using real-time information, from planning a trip to reaching one’s final destination as quickly and efficiently as possible. A platform environment for the application is currently under consideration with the University of Arizona’s CATS. The application will safely and securely monitor and assist regional travelers with trips, all while protecting individual privacy.
The application will include active transportation demand management strategies such as:

- Incentive programs to encourage drivers to leave before or after peak times, use other modes, or school/work carpool to reduce the number of vehicles on the road

- Multi-modal route planning to enable users to use and combine driving, transit, bicycling and walking modes of transportation

- Incentive programs to encourage safe driving speeds, low acceleration and not using a cell phone while driving

- Payment options for transit and public parking

- Ride sharing options

- Real-time routing to avoid congestion and road closures related to construction, weather, incidents and special events

The goal of MOD incentive strategies is to reduce vehicle-miles traveled during peak periods, to reduce delay and improve safety to negate the need for costly infrastructure investments. The level and type of incentives will need to be determined and funding secured to support any monetary incentives (note that needed funds will likely be a fraction of the cost of constructing and maintaining new roadway infrastructure).

The MOD platform will provide a user-focused experience offering travelers the options and information they need to choose the best travel options for themselves while also providing an efficient, safe, sustainable, and equitable transportation system for the community as a whole.
IMPLEMENTATION EXAMPLE

MOD programs could be coordinated with employers to provide flexible schedules, telework options and ride share opportunities to reduce peak travel and enhance mobility performance, thereby reducing overall transportation supply costs all while enhancing quality of life and environmental impacts. Employer-Based incentive program examples are provided below.

- Educate employers about any existing corporate tax benefits they could receive to offer employees pre-tax savings for transportation assistance
- Develop a regional vanpool program to allow employers or employees to participate and receive a financial contribution to help offset the cost of the van lease
- Develop an employer based transit program to allow employers to buy transit passes in bulk at a discounted rate
- Develop a Try Transit program to allow individuals who live within a specified distance of a transit route to receive a free 30-day transit pass
- Develop a recognition program to recognize employers for providing flexible schedules, telework options and ride share opportunities based on employee participation

MOD programs could also be coordinated with existing community programs, such as the City of Tucson Million Tree initiative, such that more trees could be provided to neighborhoods where the residents participate in MOD safety or multimodal programs thereby encouraging neighbors to adopt more sustainable travel behaviors.

Standards and Interoperability

As the County introduces new technologies and applications to implement MOD, partnering with other jurisdictions in the region is essential for a seamless experience for roadway users as they travel across jurisdictional boundaries.

Pima County engages in several collaborative efforts to ensure best standards and interoperability. For example, the PAG Transportation Systems Safety Subcommittee serves as a forum to collaborate and share strategies related to traffic operations. Additionally, PCDOT and TDTM continue to work together in the development of consistent design guidelines for the region.
PCDOT continually develops and revises Standard Operating Procedures and guidelines to optimize workflow and provide consistent and clear guidance for the public and staff. The PCDOT and TDTM Pavement Markings and Signing Manual was updated in 2020 to reflect the latest federal guidance. The Roadway Design Manual and Subdivision Street Standards are being combined into a single Street Standards Manual to create a performance-based design manual that includes context-sensitive design elements with a multimodal focus and demand management strategies.

There are instances where existing roadway geometrics do not prescriptively align with County guidelines and where a data-driven approach must be utilized to achieve optimal design. A systemic approach is needed to determine existing pavement allocation for travel lanes, shoulders and buffers, and roadside features based on factors such as the safety, mobility, roadway width, and surrounding land use for existing conditions. Expansive roadway cross-sections can result in increased vehicular speeds, reduced safety and require more pavement maintenance. Drivers may perceive that they can drive fast based on the visual cues received from wide, straight stretches of pavement with no obstructions on either side, coupled with limited enforcement. Factors such as access, speed and surrounding land use must be evaluated to determine the recommended roadway design, traffic control devices and potential demand management strategies that could be implemented based on maximizing community value return on investment.

**IMPLEMENTATION EXAMPLE**

PCDOT implemented the San Joaquin Road pavement test section in order to methodically evaluate various pavement repair and preservation treatments for durability and cost effectiveness; tests such as these are an important part of a data-driven approach to policy and practice decision making.

Pavement preservation, such as a mill and overlay of an existing roadway, is an opportunity to modify the existing allocation of pavement through pavement marking modifications. Pavement marking modifications are a cost effective approach to implement a road diet, painted buffers or decreased lane widths for specific locations based on an analysis of multimodal safety and mobility. An example of a proposed implementation is on Bald Eagle Avenue from Linda Vista Boulevard to Camino de Oeste. The pavement width will be reallocated to include a painted buffer and paved shoulder for each approach direction to encourage multimodal use. Eliminating the expansive through lanes is expected to result in a decrease to vehicular speeds due to appearance of less expansive pavement, as pavement width is appropriately re-allocated.
Further geometric designs that enhance bicycle comfort and encourage multimodal use will be evaluated such as protected intersections. This design reduces the amount of bicycle interaction with vehicles, reduces right-turn vehicle speeds, creates a protected area for bicycles waiting to turn, and enhances bicycle visibility. This design example could also be considered at existing signalized intersections based on existing geometrics and surrounding land use after evaluation of potential impediments to the design. Opportunities will be pursued to implement these types of safety and functionality examples during pavement repair operations.
Performance metrics will also be evaluated as part of updated standards to evaluate the effects of MOD and demand management strategy implementation. A sample of performance measures includes the following:

- Transit passenger trips per revenue mile is a key indicator of service effectiveness that is influenced by the levels of demand and the supply of service provided
- The number of employers offering flexible schedules, telework options and ride share opportunities to gauge the amount of participation and effects of such programs
- The quantity of subscribers to the MOD application to determine the effectiveness of outreach efforts and incentives
- Vehicular speed differentials following MOD incentive implementation and any roadway design modifications
- Miles traveled by mode to evaluate multi-modal usage
- Network road condition PCI to evaluate funding and maintenance prioritization
- Carbon emissions to evaluate health and climate impacts
- Serious injury and fatal crash quantity to evaluate network safety
- Delay quantity to evaluate roadway congestion and traffic signal coordination

Innovative First and Last Mile Solutions

The first and last mile of a roadway user’s trip often presents the most significant barriers to allowing users to freely and conveniently adopt more efficient, multimodal travel behaviors.

IMPLEMENTATION EXAMPLE

The future regional MOD application is envisioned to generate complete trip transportation options, including pedestrian routes, and scooter or bike rental locations that can provide the first and last mile portion of trip planning for those living in the urban areas. For those in rural areas, shared mobility options may be available. The application will include cost, time and incentive information so that the user can choose from a variety of transportation options.

Connected Vehicles and Infrastructure

Technology related to connected vehicles is being developed and implemented by private industry in the cars we drive. Pima County is planning the MOD and traffic signal network communication standards to seamlessly integrate with these new communication systems as they emerge.

IMPLEMENTATION EXAMPLE

PCDOT plans to upgrade its traffic signal network to 5G, fiber optic, or a combination thereof in order to obtain the speed and latency needed to support connected vehicles, including GPS-based preemption for emergency responders.

Summary

The need to address ongoing multimodal safety and mobility issues, as fatalities continue to rise, travel performance drops and escalating costs outpace revenues, requires Pima County to identify and evaluate new strategies, materials and technologies to provide and maintain a cost-effective and sustainable multimodal transportation system. The approach outlined in this document takes advantage of technological advancements to optimize current system performance and travel equity in lieu of solely relying on infrastructure expansion solutions. It focuses on utilizing existing infrastructure to implement both supply and demand-side solutions, thereby optimizing complex transportation and mobility issues.

As the region contemplates how it will invest in its transportation system, it has a choice between a plan that continues the unsustainable status quo and one that better aligns with future technological and community values. The PCDOT vision, which incorporates MOD principles throughout all functions, will allow the County to realize the best return on its transportation investments by embracing opportunities within a quickly innovating transportation sector.