Transportation Planning for Uncertain Times

Decision Making under Conditions of Deep Uncertainty (DMDU)

U.S. Department of Transportation
Federal Highway Administration

TMIP
Better Methods. Better Outcomes.

## Planning Successfully When the Future Is Deeply Uncertain

Emerging planning methods can help agencies navigate today's deeply uncertain conditions and better position them for tomorrow's opportunities.

Recently developed methods and analytic tools (known collectively as Decision Making under Deep Uncertainty— DMDU) can help transportation planners identify and evaluate such strategies.

Traditional predict-then-act planning begins by seeking consensus on how the future will unfold and uses this information to rank alternative plans. In contrast, DMDU begins by proposing alternative strategies to meet specific goals and then stress-testing them over a range of plausible futures. See figure 1.

DMDU can bring value to agencies, enabling them to develop plans that avoid unanticipated surprises and exploit novel opportunities. By systematically exploring a broader range of scenarios and assumptions than with traditional modeling approaches, DMDU brings a more strategic perspective in the face of dynamic change to agencies and the communities they serve. DMDU is also designed to support a participatory process called "deliberation with analysis" which can help MPOs implement the types of stakeholder engagement they need to improve their plans, build legitimacy, gain buy-in with their publics, and satisfy Federal requirements for stakeholder participation.

Figure 1: Predict-then-Act and DMDU analysis.
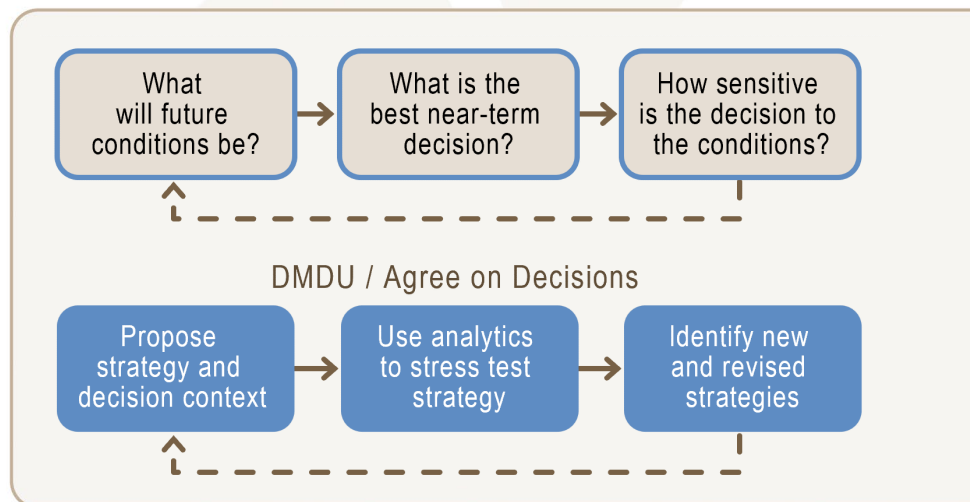
Source: RAND, adapted from Kalra, N., S. Hallegatte, R. Lempert, C. Brown, A. Fozzard, S. Gill and A. Shah (2014)

Figure 2: DMDU Adaptive Plans Learn Over Time.
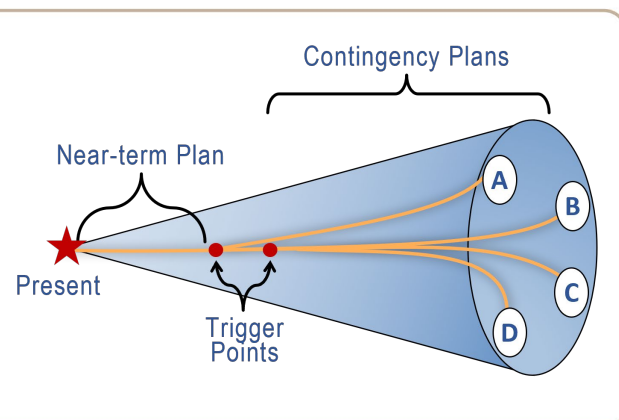
Source: RAND, adapted from Kaatz, L. (2015)

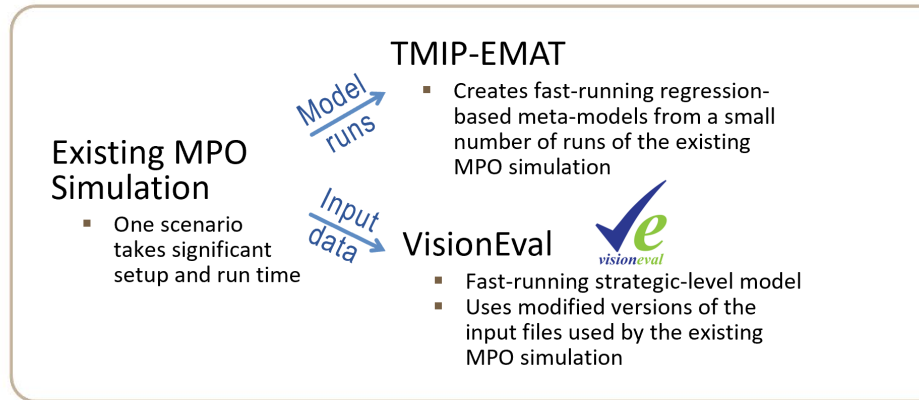## Creating New Opportunities for Transportation Planning

Transportation agencies are seeking more participatory planning processes with stakeholders pitched at a strategic level. DMDU methods are designed to help stakeholders gain a common understanding of potential vulnerabilities and opportunities of proposed plans.

DMDU methods are most useful when probabilistic forecasts are unavailable or when there is low confidence in or significant disagreement regarding any such estimates. Some DMDU applications avoid the use of probabilities, seeking to identify strategies with low regret over a wide range of futures. See figure 2 for how DMDU Adaptive Plans learn over time.

Other DMDU applications treat probability distributions as among the uncertainties and identify a probability threshold.

Software packages such as TMIP-EMAT and VisionEval have been purpose-built to help transportation agencies implement DMDU to gain a more strategic perspective within their planning cycle. Figure 3 highlights the TMIP-EMAT and VisionEval softwares for obtaning simulation models for DMDU analysis.

Figure 3: Alternatives for obtaining a simulation model for DMDU analysis.

Existing MPO Simulation
- One scenario takes significant setup and run time

Model runs →

TMIP-EMAT
- Creates fast-running regression-based meta-models from a small number of runs of the existing MPO simulation

Input data →

VisionEval
- Fast-running strategic-level model
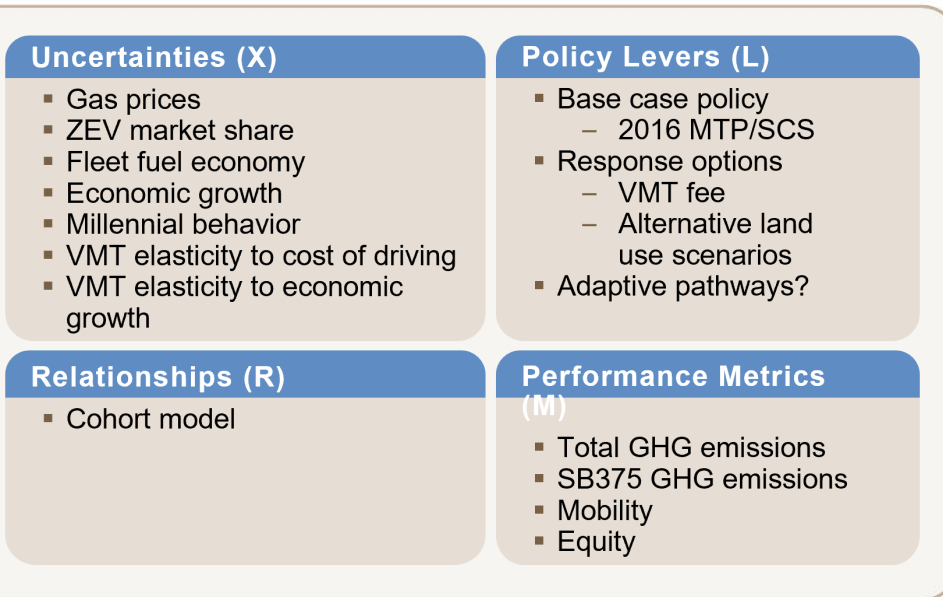- Uses modified versions of the input files used by the existing MPO simulation

Source: RAND

Applying DMDU in Transportation

Transportation agencies have begun to employ DMDU methods. The Sacramento Area Council of Governments (SACOG) used DMDU to stress-test its ambitious plan to meet climate targets while advancing mobility and equity goals.

Figure 4: "XLRM" Framework (Scoping) in SACOG RDM analysis

Uncertainties (X)
- Gas prices
- ZEV market share
- Fleet fuel economy
- Economic growth
- Millennial behavior
- VMT elasticity to cost of driving
- VMT elasticity to economic growth

Policy Levers (L)
- Base case policy
  - 2016 MTP/SCS
- Response options
  - VMT fee
  - Alternative land use scenarios
- Adaptive pathways?

Relationships (R)
- Cohort model

Performance Metrics (M)
- Total GHG emissions
- SB375 GHG emissions
- Mobility
- Equity

Source: Transportation Planning for Uncertain Times, 2022

The result from DMDU analysis suggested that SACOG's ability to meet the mobility, equity, emissions calculated according to the rules of SB 375 and total GHG emissions goals in its 2016 MTP/SCS is very sensitive to many exogenous uncertainties visualized in figure 4.

The analysis identified the external trends that would most threaten the plan's ability to meet its goals and suggested means to reduce those vulnerabilities.

Additional Resources

For the full report of Transportation Planning for Uncertain Times, visit https://www.fhwa.dot.gov/planning/tmip/publications/other_reports/

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