Oregon Statewide Integrated Model

What it is: the Oregon Statewide Integrated Model (SWIM) is a data driven forecast model designed to represent the Oregon economy with respect to land-use and transportation by simulating the activity and market exchanges made by people and businesses. Household and business location decisions are simulated, as well as the travel generated by activities such as commuting to work, purchasing commodities for industrial production and transporting final goods to markets within Oregon and outside of the state. It is designed for statewide and regional long-range transportation planning and policy analysis. Information from the SWIM is designed to inform other modeling tools, such as metropolitan planning organization travel models, freight models, and regional studies.

Why it is important: SWIM is designed to serve as a testing ground to evaluate "what if" scenarios related to areas the state can influence, such as public policy related to taxes, fees and land use rules; areas the state cannot influence, such as commodity prices, national recessions, and population growth; and other areas impacting decisions related to the Oregon transportation system.

Why it was developed: In the early 1990s there was federal interest in developing tools that integrate land use, transportation, economics and the environment. The Federal Intermodal Surface Transportation Efficiency Act (ISTEA, 1991) and the 1990 Clean Air Act Amendments were enacted so local and state agencies could do a better job of coordination on land use and transportation decisions. In response to these acts, the level and type of analysis and information requested from modeling and analysis tools and methods changed nationally.

Oregon's response to these new mandates was formation of the Oregon Modeling Improvement Program in 1994. The program was implemented cooperatively, led by the Oregon Modeling Statewide Collaborative, which includes membership of over 15 public agencies[1]. The collaborative seeks to improve state-of-the-practice and promote state-of-the-art modeling in Oregon and serve as a consensus forum and support group to coordinate land-use-transportation modeling efforts of federal, state, regional and local agencies. SWIM development included extensive technical review by national and international experts.

Analysis Examples

SWIM has been used for a variety of analyses, several examples are provided below. For a more extensive list, see the SWIM applications wiki page:

Identifying Potential Electric Vehicle Corridors for Highway Electrification (2022): SWIM was used to identify trips defined as short and long to evaluate potential locations suited for siting electric charging stations across the state.

Oregon Freight Plan (2022): SWIM provided current and forecast freight flows by tonnage and value to support the 2023 update to the Oregon Freight Plan.

[1] For historical reference, the original name of the Oregon Modeling Statewide Collaborative was Oregon Modeling Steering Committee.

Commodity Flow Data for ODOT Research Project SPR 843 (2021): SWIM provided freight commodity flow data for 70 different locations at risk of landslides, flooding and other hazards on the US-101 corridor. This data was used to explore different methods of prioritizing transportation investments on US-101.

I-5 Boone Bridge Southbound Auxiliary Lane Impacts to Forecast Land Use (2020): SWIM was used to evaluate potential impacts of the Boone Bridge project on land use beyond the project study area. Auxiliary lanes are designed to improve traffic flow and reduce disruption caused by crashes and lane weaving. Auxiliary lanes do not typically add capacity to a facility, since they are not through lanes, but they do help restore capacity to existing through lanes. Forecast land use, local traffic volumes and regional vehicle-miles-traveled were evaluated for potential changes in the future influenced by this project. Results indicate the project will not trigger unexpected land use development outside of the project area, nor increase regional travel.

Landslide Showcase (2019): SWIM was used to prepare two case study examples quantifying the economic impact landslides have on transportation system users. Closures caused by landslides were simulated and users' alternative routes were traced in a manner that identified the additional travel time and distance required to reach their destinations, for passenger vehicles and freight trucks. Freight commodities were also reported. The additional travel time and distance was monetized to quantify the economic impact to users from a one-day closure.

Hood River Toll Bridge Forecast Traffic and Sensitivity Analysis (2018): The Port of Hood River 2020 Supplemental Draft Environmental Impact Statement for the Hood River – White Salmon Bridge Replacement project relied on SWIM to estimate forecast traffic volumes on the bridge. SWIM was also used to evaluate several different truck toll rates to learn how tolls impact demand for bridge crossings.

Rough Roads Ahead 2: Economic Implications of Deteriorating Highway Conditions (2017): SWIM was used to prepare a high-level strategic comparison between the current ODOT forecast budget and an alternative budget designed to preserve and maintain current conditions of state highways, roads and bridges. The analysis provided a sense of the magnitude of potential economic impacts of deteriorating bridges and pavement. Results indicated deterioration would place Oregon at a competitive disadvantage, with the potential to lose up to 120,000 jobs and $605 billion in gross state product, and raise household and business expenditures for vehicle operating costs from $300M to $450M (50% increase) per year.

Newberg Bypass Impacts to Wilsonville Road Traffic Volumes (2015): ODOT was asked to evaluate potential impacts of the Newberg Bypass on Wilsonville Road. Local residents were concerned that the impacts had not been captured in previous analysis, SWIM was used to conduct the analysis and compared to previous results. This separate analysis produced results consistent with the past project analysis, confirming there does not appear to be any new risk of traffic shifting to Wilsonville Road.

Seismic Bridge Options Economic Impact Analysis (2013): SWIM was used to produce high-level estimates of avoidable economic impacts associated with a major seismic event on the Cascadia

Subduction Zone. The analysis provided a general sense of the magnitude and direction of avoidable economic impacts compared to the investment needed for a pre-emptive mitigation program. Findings indicated investing $1.8 billion toward seismic mitigation would avoid the loss of $84 billion in Oregon gross domestic product, which results in a benefit/cost ratio of 46. Accounting for the estimated 12 percent chance of the earthquake occurring within the next 50 years adjusts the benefit/cost figure to 5.6, further indicating mitigation investment is a sound business decision for Oregon.[2]

Oregon Freight Plan (2010): SWIM was used to evaluate the variation in statewide and regional economic activity and commodity flow in order to evaluate uncertainty associated with economic volatility on alternative Freight Plan strategies. This information enabled decision makers to better assess the robustness of freight strategies and avoid the creation of barriers prohibiting the freight industry from reacting nimbly to economic change.[3]

Oregon Transportation Plan Update (2005): SWIM was used for scenario analysis designed to develop a long-range plan that is effective and relevant under conditions of uncertainty in several key areas. Two sensitivity scenarios were used to evaluate impacts of higher fuel prices and more relaxed land use policies affecting available land for future development on urban boundaries and rural areas. Four policy scenarios provided information evaluating different funding options, program priorities and other related issues.[4] This modeling analysis earned ODOT an FHWA/FTA Transportation Planning Excellence Award.[5]

Economic & Bridge Options Report (2003): SWIM was used to examine the economic impacts of expected bridge weight limits throughout the state due to an increasing number of cracking problems on aging bridges. The model simulated the response of trucks to bridge weight restrictions and quantified the impacts on statewide and regional industry production and jobs, transportation costs and changes in travel and land use patterns. The model estimated Oregon's bridge problem could cost the state as much as $123 billion in lost production and 88,000 forfeited jobs over the next 25 years.[6]

Newberg-Dundee Bypass (2002): SWIM was used to evaluate the potential for a bypass to induce additional development in Yamhill County. A concern regarding induced growth associated with the bypass has been a significant issue in the bypass planning process. The SWIM was used successfully to evaluate the nature and general magnitude of induced growth effects. The results were very important to the land use exceptions process and a subsequent court appeal.[7]

Eastern Oregon Freeway Alternative (2001): prompted by a legislative directive (HB3090) to ODOT to study the construction of a new freeway, SWIM was used to evaluate whether population and traffic

---

[2] http://www.oregon.gov/ODOT/TD/TP/docs/Statewide/CascadiaSubductionZoneEarthquake_EconomicImpact_2012.pdf

[3] http://www.oregon.gov/ODOT/TD/TP/docs/ofp/ofpmodelingmemo.pdf

[4] http://www.oregon.gov/ODOT/TD/TP/docs/otp/analysis.pdf

[5] http://www.oregon.gov/ODOT/TD/TP/docs/Statewide/2008_OTP_award.pdf

[6] http://www.oregon.gov/ODOT/TD/TP/docs/statewide/econbridgerpt.pdf

[7] http://www.oregon.gov/ODOT/TD/TP/docs/statewide/newbergdundee.pdf

growth would be diverted from the Willamette Valley to regions east of the Cascades. Analysis revealed a new freeway would not shift growth away from the Willamette Valley.[8]

Willamette Valley Livability Forum (2001): This was the first analysis conducted using the newly developed Statewide Integrated Model. The forum initiated a comprehensive regional visioning process for future land use and transportation in the Willamette Valley. Modeled scenarios varied by land use, road networks, public transit networks and mileage tax. By modeling various combinations of policy options, decision-makers identified likely conditions which influenced adopted policies shaping the Willamette Valley for future generations. [9]

Model Design Features

The Statewide Model is described as an "integrated" model because the sub-models are interconnected. Information is shared back and forth between the sub-models, mimicking the reactive and interactive behaviors observed in the real world. The model is designed to represent how people and businesses share information and exchange goods and services based on prices and location. The integrated modular design better represents real-world conditions and activity, but requires an immense amount of data, significant development time, powerful computing capabilities and trained staff. For these two reasons, very few states have a statewide economic, land use and transportation model like Oregon's.

The Oregon Statewide Integrated Model consists of specialized sub-models that interconnect with each other:

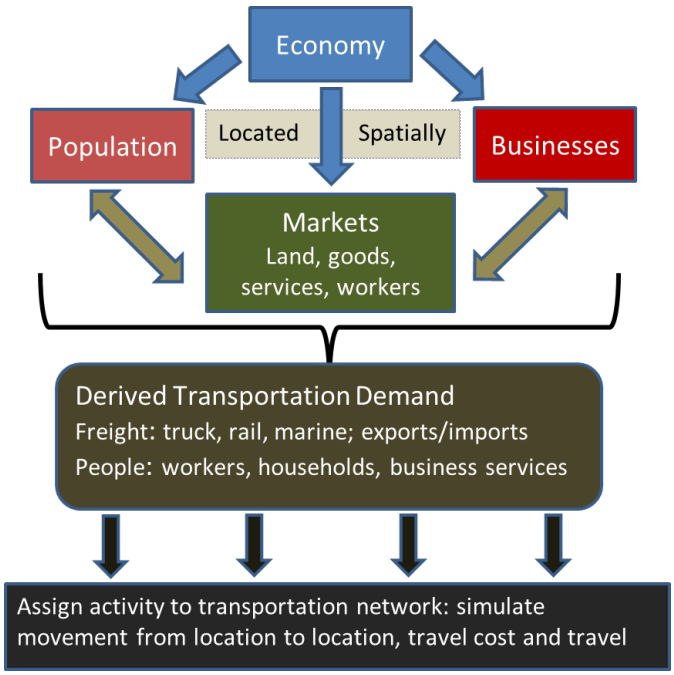
- **Economic Model**: based on the official state revenue forecast prepared by the Department of Administrative Services, Office of Economic Analysis; provides statewide totals for employment by industry, inflation rate, imports and exports, unemployment rate.
- **Population Synthesizer**: simulates a population with observed Oregon characteristics such as age, household size, household location, income, occupation, worker/non-worker/student status.
- **Production Location Model**: simulates where businesses locate, the commodities they purchase to use as production inputs, number and type of workers hired, the amount of floorspace they purchase/lease for their production facility, and production of goods and services sold based on market prices.
- **Land Development Model:** identifies land availability based on floorspace prices and vacancy rates for firms and households to rent or purchase.
- **Person Travel**: simulates person activity for a typical weekday for the people simulated by the Population Synthesizer; activity involving travel is assigned a travel mode such as auto, transit, or rail.
- **Commercial Goods Transport**: simulates how commodities are moved as freight by different modes of transport, such as marine, rail, and truck for a typical weekday.
- **External Goods Transport**: simulates freight movement for exports, imports and through the state.

[8] http://www.oregon.gov/ODOT/TD/TP/docs/statewide/hb3090.pdf
[9] http://www.oregon.gov/ODOT/TD/TP/docs/statewide/smap.pdf

- **Transport Model**: assigns trips to a computer network, trips generated in the Person Travel Model, Commercial Goods Transport model, External Goods Transport model.

  Figure 1 illustrates the interaction and connections between the different activities represented within the model via the specialized sub-models.

Figure 1. SWIM2 Schematic



SWIM is often used for scenario analysis. A reference scenario is developed to represent current conditions or policy most likely for a 20-year planning horizon. Alternative scenarios are developed to represent the "what if" areas of analysis. This way, a range of potential futures are identified and implications associated with uncertainty can be assessed. Typically, SWIM is used to evaluate potential impacts on employment and gross state product. Other elements of the model may be reported, but the level of reporting depends on the level of detailed data prepared for the model setup. The full model documentation is available online here: https://github.com/tlumip/tlumip/wiki.

For further information, contact Becky Knudson.