Assessing the Use of Agent-Based Models for Tobacco Regulation

An Evaluation Framework for Policy-Relevant Agent-Based Models

Agent-based computational models (ABMs) examine how individual elements, or agents, of a system behave as a function of individual characteristics, the environment, and interactions with each other. Each agent interacts with other agents based on a set of rules and within an environment specified by the modeler, which leads to a set of specific aggregate outcomes, some of which may be unexpected. With these capabilities, ABMs have the potential to provide a deeper understanding of complex behaviors and interactions of diverse individuals and their environment, and to inform policy making.

Since 2009, the U.S. Food and Drug Administration (FDA) has had broad regulatory authority over tobacco products and has used models as one tool to guide policy. FDA asked the Institute of Medicine (IOM) to convene a committee of experts to provide guidance on using ABMs to inform decision making for tobacco control policy. The resulting report, Assessing the Use of Agent-Based Models for Tobacco Regulation, describes the complex tobacco environment and provides key recommendations for policy makers and modelers to consider when developing ABMs. The committee also recommends a formal process to guide rigorous model development and evaluation.

This document highlights the five major categories of the evaluation framework, which were developed by the committee based on best practices identified in a number of modeling fields across disciplines. A figure showing the framework is on the reverse side of this document.

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<td>Policy-relevant ABMs are resource-intensive, requiring both financial and human resources. These resources include access to the relevant subject matter experts, data, and other infrastructure to inform the model. Appropriate resources are also needed to disseminate model findings.</td>
<td>The relevant social and behavioral processes need to be captured meaningfully. Relevant data should inform policy-relevant ABMs throughout the modeling process. For those data that are not available, regulatory agencies like FDA should help identify and collect these data. Subject matter experts are needed throughout the model development process, from deciding which modeling approaches are appropriate for the question at hand to interpreting and communicating model results.</td>
<td>The outputs from the conceptual development stage may include causal maps, conceptual frameworks, and the general model design document. The model results include agent- and aggregate-level data as well as the statistical analyses of these data. To ensure that decision makers understand the scope of the model and properly apply the modeling results, the documentation of this model’s limitations and uncertainties is an important output.</td>
<td>Comparing the results of a policy-relevant ABM with other types of ABMs or other types of models that approach the same question would increase the policy makers’ confidence in the model results. Policy makers need to work with model developers and subject matter experts to make changes to the model based on newly available data, and to decide how to apply the model for short- and long-term use. The ultimate utility of the model rests on the extent to which model results have influenced policy and led to improved population health.</td>
<td>Changes in the environment, such as policy priorities, may influence model development. These external factors are typically not the focus of an evaluation, but the evaluator needs to be aware of these influences so that the evaluation results and conclusions can be put into the appropriate context.</td>
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Figure 1: An Evaluation Framework for Policy-Relevant Agent-Based Models

Resources
- **Financial Resources**
  - Funding for model development
  - Funding for data acquisition
  - Funding for model dissemination & data sharing
- **Infrastructure Resources**
  - Hardware resources
  - Software resources
- **Human Resources**
  - Availability of core modeling staff with required expertise
  - Availability of relevant subject matter experts
  - Availability of funding, policy making, regulatory staff (funders and end-users)
- **Knowledge Resources**
  - Accurate information about current and proposed public health policies and regulations
  - Access to relevant empirical data (epidemiologic, behavioral, public health system, tobacco industry)

Activities
- **Conceptual Development**
  - Development of work task and model goals
  - Development of conceptual model or causal map
  - Definitions of model components (agent characteristics, agent rules, environment)
- **Model Implementation**
  - Development of prototype models
  - Development of full model or model modules
- **Model Testing & Validation**
  - Examine basic model behavior
  - Identify problems and interesting model behavior
  - Perform sensitivity analysis
  - Validate model outputs against theory and existing data
- **Policy Testing**
  - Examine effects of introduction of new policies or regulation
  - Conduct policy experiments that compare multiple policies or regulations
- **Communications**
  - Share initial results with stakeholders
  - Identify data gaps and communicate with empirical scientists
  - Develop appropriate data and communication platforms for model

Outputs
- **Frameworks**
  - Conceptual framework
  - Causal map
  - Model design document
- **Model Development System**
  - Model code
  - Formal model development management systems (e.g., versioning system)
  - Empirical databases
- **Model Results**
  - Systematic storage of model output data
  - Interpretation of important model results
  - Model limitations and uncertainties
- **Policy Results**
  - Description of policy effects
  - Identification of promising policies, policy leverage points, implementation strategies
- **Communications**
  - Dissemination model (description, results, raw data, code)
  - Share model results to multiple stakeholders (funders, policy makers, scientists)
  - Use multiple channels for dissemination (reports, papers, web, social media)

Outcomes
- **Short-term**
  - Update model based on sensitivity, validation results
  - Clarification of model goals based on early results, feedback from stakeholders
  - Adapt policies and regulatory options being tested based on model results
- **Intermediate**
  - Diffusion of new tobacco control knowledge among funders, regulators, policy makers, scientists
  - New regulatory and funding announcements
  - Public health scientists collect new data to inform future model development and policy research
- **Long-term**
  - Implementation of evidence-based tobacco control policies & regulation
  - Improve population health via:
    - Reducing product harms and addictiveness
    - Preventing youth initiation
    - Increasing adult cessation

**Environmental Influences** – Political, Scientific, Financial

NOTE: Chapter 4 of the report provides additional detail about each category as well as sample evaluation questions for these categories.

For more information, visit [www.iom.edu/TobaccoModeling](http://www.iom.edu/TobaccoModeling)