

## ABSTRACT

Vander Schaaf, Reid Evan, Ph.D., Purdue University, May 2008. A System-of-Systems (SoS) Approach for Improved Decision-Making in Infrastructure Project Selection Problems. Major Professors: Dulcy M. Abraham and Daniel A. DeLaurentis.

Decision-makers facing project selection decisions have a continuing need for quantitative methods that enable informed decisions to be made in the midst of system complexity. A particular source of complexity stems from the interaction of involved organizations that bring differing perspectives and objectives, i.e., decision dynamics of a system of organizations. This is true in particular for the selection of Department of Defense (DoD) sponsored humanitarian projects in host nations, where interconnected and sometimes conflicting objectives among a system of organizations are present. Discernment of which projects in particular advance the multiple causes is difficult. In the midst of complexities involving diverse locales and competing organizational interests, decision-makers need relevant, actionable information that uncovers good solutions in the system-of-organizations (SoO).

This research investigates the impacts of (i) organizational topology, (ii) stakeholder relationships (levels of competition and communication) on that topology, and (iii) civil infrastructure network factors (condition, type, capacity) on decision-making processes in a SoO. Additionally, it explores whether an agent-based simulation can provide a realistic quantitative model that can translate to actionable information for decision makers for improved project selection. The framework developed is validated using the testbed of organizational decision-making under a constrained environment for the U.S. Department of Defense humanitarian project selection.

This research takes advantage of the relatively recent developments in the fields of agent-based modeling (ABM) and uses ABM simulations of the organizational topology that include the relationship between the entities (e.g. link traits) in the DoD humanitarian infrastructure project selection process. Additionally, 'greedy' multi-objective optimization models were constructed to establish a baseline, bounded set of outcomes optimized for a single organization so that comparisons can be made to the SoO implemented in the agent-based simulation that incorporates topology and link trait variables. This investigation demonstrated that modifying the topology of the SoO resulted in significant changes in the types of projects selected. The comparison of the 'greedy' optimization model with the ABM demonstrated that an agent-based approach to project selection was viable, and for the testbed provided a better match with historical project selection than the optimization model. Also, the ABM created for project selection can be used for additional investigation into the effects of changing the topology of the organization, which is not possible with a more traditional optimization modeling approach. The condition of the existing infrastructure networks was shown to have minimal impact on the projects selected, although it did affect the material cost of the projects. An examination of the role of corruption/ bribes showed that the U.S. projects selection strategy was susceptible to bribery within the HN nomination process.