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14. ABSTRACT

In this paper, we present initial findings from a research effort to build a business intelligence platform that incorporates data-driven models, such as Bayesian belief networks, and goal-driven models, including multi-criteria decision analysis (MCDA), into a geospatial environment to support decision making for campaign management. Our development approach supports tactical level commanders at the brigade, battalion, and company level, providing operationally relevant information on the relationships between factors driving the insurgency and leverage points for planning and executing more effective operations. The Decision Modeler tool will be used to support counterinsurgency and stability operations by allowing users to interactively construct MCDA models to evaluate and compare alternative outcomes for specific lines of effort. MCDA is a discipline that supports decision making in the presence of several conflicting or uncertain factors, while assisting the decision maker identify the objectives, factors and metrics to support the decision goals. This process is designed to support the analyst from early planning of an operation, through the selection of evaluation criteria, automated population of relevant socio-cultural data, to the generation and calculation of alternative ranking scores.

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DECISION MODELING FOR SOCIO-CULTURAL DATA

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ABSTRACT

In this paper, we present initial findings from a research effort to build a business intelligence platform that incorporates data-driven models, such as Bayesian belief networks, and goal-driven models, including multi-criteria decision analysis (MCDA), into a geospatial environment to support decision making for campaign management. Our development approach supports tactical level commanders at the brigade, battalion, and company level, providing operationally relevant information on the relationships between factors driving the insurgency and leverage points for planning and executing more effective operations. The Decision Modeler tool will be used to support counterinsurgency and stability operations by allowing users to interactively construct MCDA models to evaluate and compare alternative outcomes for specific lines of effort. MCDA is a discipline that supports decision making in the presence of several conflicting or uncertain factors, while assisting the decision maker identify the objectives, factors and metrics to support the decision goals. This process is designed to support the analyst from early planning and conceptualization of an operation, through the selection of evaluation criteria and automated population of relevant socio-cultural data, to the generation and calculation of alternative ranking scores and visualization of results.

PRIMARY TRACK

Analytic Methods Science and Technology (S&T)

SECONDARY TRACK

Application of Social Cultural Methods, Models, and Tools (MMT)

DESCRIPTION

In our discussion we will report initial findings from a research effort to build a business intelligence platform that incorporates data-driven models, such as Bayesian belief networks, and goal-driven models, including multi-criteria decision analysis (MCDA), into a geospatial environment to support decision making for campaign management. This effort is part of Milcord's Predictive Societal Indicators of Radicalism (PSIR) project through Air Force Research Laboratory involving research in predictive analytics relating to low-intensity conflict. Our development approach supports tactical level commanders at the brigade, battalion, and company level, providing operationally relevant information on the relationships between factors driving the insurgency and leverage points for planning and executing more effective operations.

MCDA is a discipline for solving problems involving a set of alternatives that are evaluated on the basis of conflicting criteria. [1] An MCDA framework involves breaking the problem structure down into several components that include: (1) a goal or set of goals; (2) a decision maker's preferences with respect to evaluation criteria; (3) a set of evaluation criteria to evaluate the decision alternatives; (4) a set of decision alternatives; (5) the set of uncontrollable variables (decision environment); (6) and the set of outcomes or consequences associated with the alternative actions. [2] MCDA techniques serve decision makers as interactive tools to identify

the stakeholders, goals, objectives and criteria in a transparent manner, and help with objective evaluation of the criteria when metrics and data are available while allowing the subjective preferences of the decision maker to weigh in on the decision. [3]

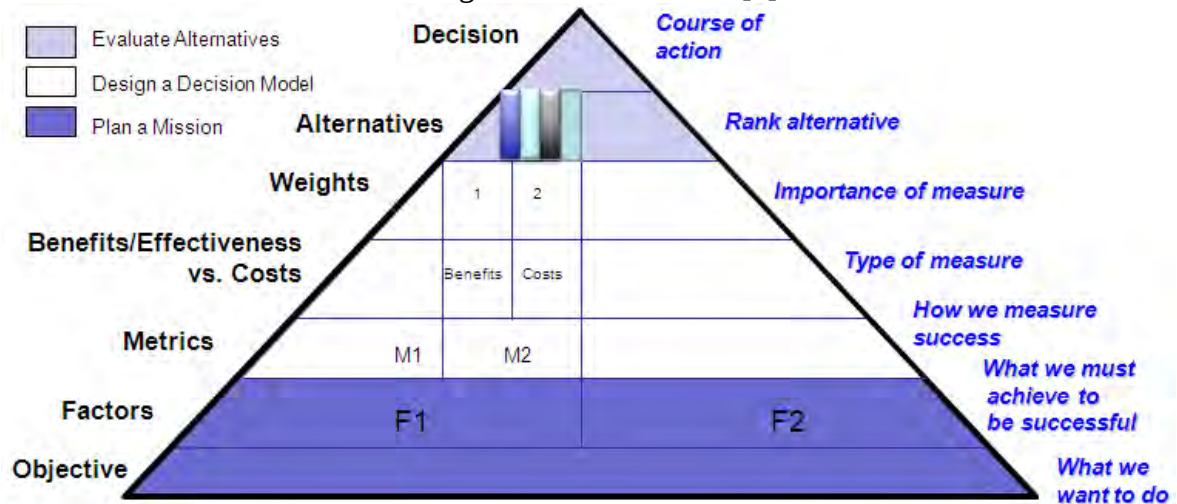


Figure 1: Components of a campaign plan for decision modeling.

Our Decision Modeling tool incorporates a weighting system that enables analysts to apply their preferences to the metrics that are most critical for the mission. Linking these decision models in a shared space within the tool creates a repository of knowledge about progress along lines of effort in an operation. The alternatives considered in the decision model are different courses of action that can be evaluated against metrics to determine the optimal action for accomplishing the commander's goals. Working in a complex human system such as the one found in counterinsurgency and stability operation environments, our tool is not meant to be a 'black box' model that simply reports to the user what to do, but rather the decision analysis provides insight through both qualitative and data-driven models about what courses of action are likely to set the conditions for a more successful outcome based on the commander's intent.

In evaluating our tool with users, we determined that one of the most important features involves the visualization of the tradeoffs for various courses of action in the decision model. To address this, we compute the uncertainty of data based on its distribution and propagate its effect analytically into the decision space, presenting it visually to the commander. A greater dispersion represents more uncertainty, while a clustered set of data points indicates more certainty regarding the cost and effectiveness metrics for a particular course of action. In this way, we are able to represent the high levels of uncertainty inherent in socio-cultural information without negatively impacting the ability of our tool to calculate a decision model. By incorporating a visual representation of uncertainty in the model, scenarios can then be played out to determine optimization for various courses of action based on data inputs and user preferences, translating model outputs into a form that can more readily be used by military users.

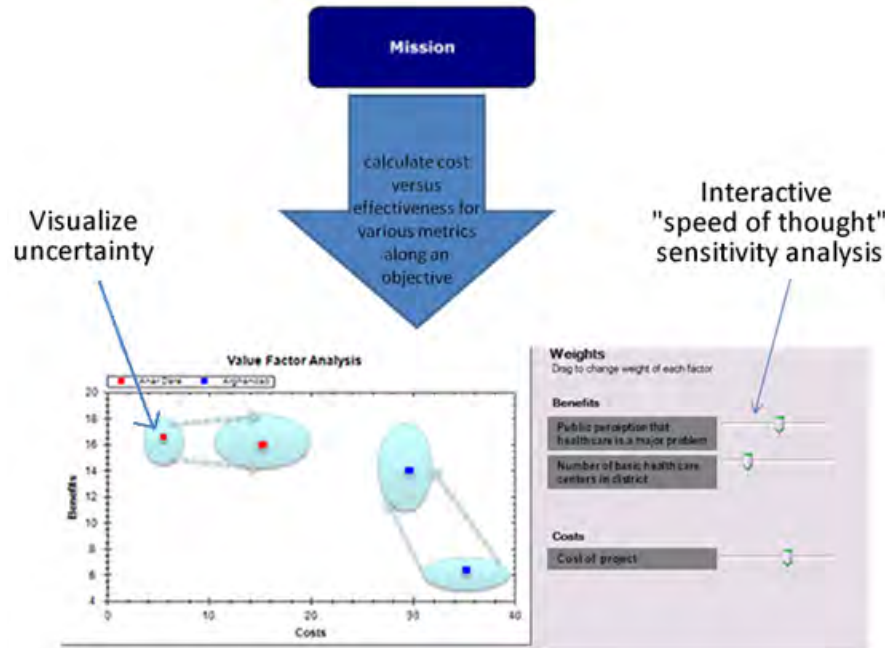


Figure 2: MCDA decision environment with interactive cost and effectiveness analysis. As cost and effectiveness data changes, points change along the axis allowing for real-time knowledge generation. The ellipses around the decision points represent the distribution and therefore uncertainty of the data in the decision space.

One of the key benefits of our approach is that it allows for real-time knowledge generation. By updating the model with new data the Decision Modeler will re-evaluate the outlined courses of action against the new information, allowing the user to view trends over time in the effectiveness and cost metrics for particular courses of action.

In addition to our MCDA templates, we have developed a business intelligence suite of applications for our tool to support complex operations management. In business intelligence, the goal is to leverage existing data, determining new insights and relationships to assist in decision making. Our tool uses an open-source online analytical processing (OLAP) approach that provides a multidimensional conceptual analysis of socio-cultural data. At its core, OLAP is based on cubic structure, consisting of facts that are categorized by dimensions. The cube structure of the data allows the analyst to easily navigate through the cube using various OLAP operations such as drilling down/up, slicing, dicing, and pivoting. OLAP provides significant benefits for analyzing data because it is designed to convert data into usable information by allowing a user to break down data into various levels to determine interesting characteristics and relationships. The OLAP functionality of our tool provides analytic capabilities for leveraging data and determining insights into the operating environment, powering data-driven stability operations. OLAP for SSTR operations will enable faster and more accurate reporting with multi-dimensional analysis. To demonstrate the utility of our approach, we will show the power of OLAP analytics through the analysis of socio-cultural survey data from Afghanistan.

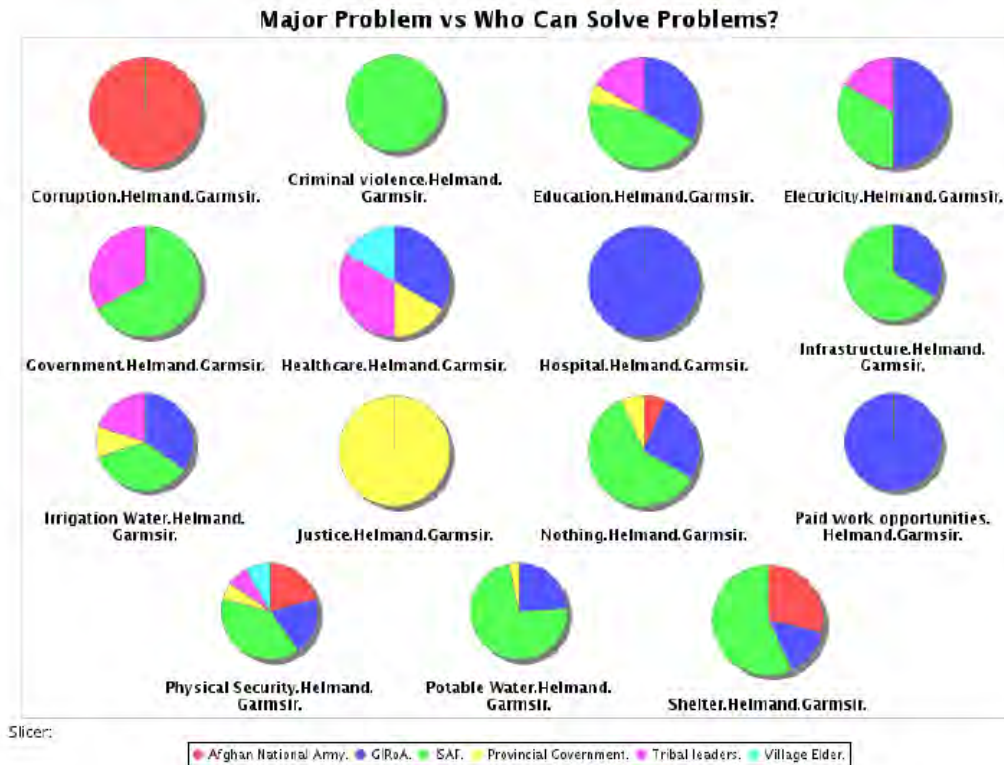


Figure 3: OLAP analytical report visualizing who respondents think can solve their problems based on what the major problem is facing their village, drilling down to review responses for Garmsir district, Helmand Province, Afghanistan. This data is part of the Tactical Conflict and Assessment Planning Framework (TCAPF) and was collected by U.S. forces in Afghanistan in 2009.

Our tool provides robust analytical capabilities for tactical level data that supports decision making for campaign management. Incorporating MCDA decision models, business intelligence platforms such as OLAP for data analysis, and Bayesian belief networks for determining conditional influences between key nodes, all of which can be mapped to a geospatial environment for visualization, assists in planning and managing campaigns in complex operations.

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BIOGRAPHY

Laura Stroh's – Research Scientist at Milcord – research interests are in insurgency and low-intensity conflict. Laura's recent research on HSCB modeling and analysis includes human terrain and political analysis in support of ISAF Joint Command, developing predictive indicators of radicalism, global models for forecasting political violence, and leveraging multi-criteria decision making in support of complex operations. Laura graduated with a M.A. in Security Studies from the Security Studies Program at Georgetown University. Her thesis, "Adapting Counterinsurgency to Networked Insurgencies: A Systems Analysis of the Insurgency

in Southern Afghanistan,” involved the application of Systems Dynamics methodology to determine the drivers of the insurgency in Helmand and Kandahar Provinces. Prior to joining Milcord, Laura was a research assistant at the Center for a New American Security (CNAS). Ms. Stroh has had five years of Arabic, including time spent in region at the Bourguiba Institute of Modern Languages in Tunis, Tunisia.

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