

Evaluation Framework for BMD System Effectiveness and Value

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Abstract: A systematic decision analysis framework was developed to understand customer perceptions of BMD weapon system alternatives and their inclination to procure a system that will help them achieve security goals. Using Quality Deployment Function (QFD), Multi-attribute Utility Theory (MAUT), and Value-Focused Thinking (VFT) a value model was developed utilizing qualitative and quantitative analysis that results in objective procurement recommendations to customers. Stakeholder analysis is critical to understanding the decision process for the customer. The customer fundamental objective, requirements, and constraints from stakeholder analysis are extrapolated to derive key system attributes. The corresponding value function score and weighting of each system attribute are applied to an additive mathematical model that produces a quantitative picture of the value of each alternative.

In order for the value of each system attribute to be scored correctly, measures of effectiveness and the value function needed to be accurately defined. Measures of effectiveness consider many technical factors that needed to be simulated in order to be objectively defined, including radar, system operability/survivability, and system performance.

For the BMD weapon system operational measures of effectiveness, the probability of kill (P_k) of a weapon system influences customers decisions because it incorporates many factors such as the incoming threat type, firing doctrine, and radar placement. Factors such as warhead density and proportion of dummy warheads to actual warheads were also investigated. A derivation of a binomial distribution was used to analyze the probability of kill for multi-layered and single-layered defensive systems. A radar model was developed to represent radar search, acquisition, track and discrimination performance in terms of probability. Deterministic analysis was then performed in order to obtain insights about dominant alternatives and their value without probability and uncertainty.

Keywords: Ballistic Missile Defense, Multi-Attribute Utility Theory, Decision analysis, Value Model