Nuclear Smuggling Detection and Deterrence Lifecycle Cost Modeling

Kassandra Guajardo¹, Angela Waterworth², Aimee Holmes²

¹ Central Washington University, 400 E University Way, Ellensburg, WA 98926
² Pacific Northwest National Laboratory, 902 Battelle Blvd, Richland, WA 99354

Introduction
Countries around the world use equipment to detect nuclear smuggling. This equipment is used at borders, airports, and seaports via screening of vehicles, boats, cargo, and individuals. As equipment is used over time, the performance of each piece needs to be maintained through preventive or corrective maintenance.

Aim
- Determine the global optimal solution of the maximum number of activities based on a budget.
- Corrective maintenance must be done before preventive maintenance.

Objective Function
Decision variables
\[ X_i = \text{indicator variable to perform corrective maintenance} \]
\[ Y_j = \text{binary} \]
\[ \text{MAX } \sum_{i} c_i x_i + \sum_{j} r_j y_j \]
S.T.
\[ C < B, \text{ where } B \text{ is budget ($) and } C \text{ is the cost} \]
\[ \text{where } d_i, d_j = \text{activity duration (hrs.); } r_i, r_j = \text{number annual failures; } f_i = \text{frequencies, } l = \text{labour cost ($)}. \]

Results
Given four maintenance types, the maximum number of maintenance activities needs to be calculated to meet the budget of $8,000.
- Using the approaches of What-if analysis and using the VBA programming, there were 16 out of 25 solutions that were desirable.
- Other solutions skipped some maintenance activities.

Conclusion
Multiple techniques exist to solve this type of problem. Programming can be used to speed up the solution process. In this case, once generating the feasible solutions was accomplished, the question became: What are the other factors that determine the optimal decision when there are many? In this case, 16 out of 25 were desirable solutions because they did not skip any maintenance activities.

Further Steps
- Consulting subject matter experts on the maintenance equipment is necessary to better understand each country’s needs and other decision factors.
- Risk analysis provides each country with possible consequences that may occur if they decide to do a limited number of maintenance activities.

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References

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For more information on the science you see here, please contact:

Angela Waterworth
Pacific Northwest National Laboratory
P.O. Box 999, MS-IN: K7-20
Richland, WA 99352
(509) 375-3839
angela.waterworth@pnnl.gov

www.pnnl.gov