

## Examination of State-Level Nuclear Security Evaluation Methods

Chan Kim<sup>a</sup>, Man-Sung Yim<sup>a</sup>

<sup>a</sup>Department of Nuclear and Quantum Engineering, Korea Advanced Institute of Science and Technology, 291  
Daehak-ro, Yuseong-gu, Daejeon 305-701

\*Corresponding author: msyim@kaist.ac.kr

### 1. Introduction

With increasing threat of terrorism, yet no truly global regime formed for nuclear security, approaches to nuclear security vary widely among states.

An effective global system for nuclear materials security needs to cover all materials, employing international standards and best practices, to reduce risks by reducing weapons-usable nuclear material stocks and the number of locations where they are found. Such a system must also encourage states to accept peer reviews by outside experts in order to demonstrate that effective security is in place [1]. It is thus critically important to perform state-level evaluation of nuclear security based on an integrative framework of risk assessment. Such evaluation provides a basis of measuring the level and progress of international effort to secure and control all nuclear materials.

Based on the review of existing literature, this research explores ways to enhance state-level nuclear security evaluation in particular with special attention on the role of terrorism. In particular the study examines ways to cover risk factors as part of the evaluation, especially focusing on the aspect of terrorism, and its correlation with state-level nuclear security evaluation.

### 2. Current Methods of State-Level Nuclear Security Evaluation

The nuclear materials security index (NMSI) by NTI is the first-of-its kind tool for public assessment of state-level nuclear materials security conditions. It ranks countries with respect to the degree of nuclear security by covering various indicators that reflect a state's international status and societal conditions mainly related to the management of nuclear materials, with the goal of guiding government policies to set priorities for nuclear security risk reduction measures. This index is quite simple to use for policy applications and comprehensive in its scope of countries covered in the measurement.

Nonetheless, the NTI index fails to address several important issues in nuclear security discussions such as proliferation risks, disarmament, the threat of sabotage of nuclear facilities, and the assessment for low-enriched uranium or radiological materials that can be used for building a "dirty bomb" [1]. Besides, certain categories are dubious as they are more or less subjectively determined by expert panels (and

furthermore, not fully open to the public).

The NTI index also relies on expert judgment for the weighting of individual indicators, which invites questions about its transparency and subjectivity. In addition, on the rankings of countries on certain indicators, external and internal views diverge, raising questions about the objectivity and the sensitivity of the NTI results.

The State Level Risk Metric by Texas A&M University (TAMU), an example of an alternative approach, provides a state's risk profile by considering threat, vulnerability and consequence space of nuclear security risk so as to assist national decision-makers in optimizing resource allocation for nuclear security risk minimization. TAMU's State-level Nuclear Security Measures covers a wide range of issues to assess the risk, such as threats of sabotage, theft of spent nuclear material, radiation material leading to the production of weapon-usable devices, which were not addressed in the NTI NMSI. This risk-based methodology employs a combination of pathways analysis, game theory, multi-attribute utility analysis, decision theory and risk analysis. It also models the adversary's strategic decision making while accounting for the capabilities, motivations, and disincentives that may influence a terrorist's choice of the target [2,3]. In short, TAMU's assessment method deals with more complex issues that were not considered in the NTI method.

Unfortunately, TAMU's research is currently under an embargo due to the confidentiality of its data sources. Openness and transparency, which is one of the important goals of establishing a state-level nuclear security framework, will be suspended because of this kind of an issue.

While the aforementioned studies by NTI and TAMU are quite comprehensive in the scope of indicators and the coverage of nations, they are relatively underdeveloped to underpinning nuclear security with increasing terrorism worldwide.

In this research, the refinement of existing methods and database has been investigated to suggest a better, integrative assessment framework for state-level nuclear security. Based on the investigation adding a new category was proposed to deal with risk factors such as terrorist groups, degree of motivation, and its capabilities.

### 3. Methods and Results

The new category examined in this study, *Risk Assessment*, is designed to assess the risk factors of terrorism and was the product of disassembly and rearrangement of existing assessment framework. The category is comprised of the existing indicators and categories of NTI NMSI, such as *Quantities and Sites*, *Security and Control Measures*, with new indicators dealing with terrorism.

The category of *Risk Assessment* is driven from the sub-indicator of *Risk Environment* from NMSI, 5.4) *Groups Interested in Illicitly Acquiring Materials*, segregated from the existing category and developed as a whole independent superordinate one rather than a sub-indicator hindering the consistency of *Risk Environment*.

To provide the score set of terrorism-related indicators, new data set was developed in this study. The new dataset was based on the information of Terrorist Organization Profile (TOP) and the Global Terrorism Database (GTD), which are the database also used for Global Terrorism Index (GTI), by Study of Terrorism, and Responses to Terrorism (START) by University of Maryland, terrorist organizations in 25 states were analyzed; 1) degree of motivation, 2) activities through recent twenty five years, 3) presence of alliances, and financial assistance were assessed [4,5].

#### 3.1 Adversary Analysis

As part of Adversary Analysis, three sub-indicators were developed, which are *Presence of Adversary*, *Motivations for Groups to Pursue the Threat*, and *Terrorist Capabilities*.

The first sub-indicator, Presence of Adversary was assessed based on the TOP database, excluding inactive groups listed for relevant countries. For the assessment of the scores, the active terrorist organization's profiles were reviewed with extra readings and research on the relevant groups.

The other sub-indicator, Motivations for Groups to Pursue the Threat, was also scored based on TOP database and GTD. The score scale for this sub-indicator is from 0 to 4, the higher score means that the stronger motivation of the terrorist group pursues. The detailed score scale standard is partially listed as table below.

Table 1: Part of Scoring Guideline for the sub-indicator Motivations for Groups to Pursue the Threat

Degree of Motivation	Score	Note
Extreme	4	1. The group has announced that they are interested in acquiring nuclear materials, or

		interested in committing sabotage the nuclear related facilities (ex) The most well-known, notorious organization such as al-Qaeda  2. From the GTD (Global Terrorism Database); target type is majorly focusing on government, police, military base and airport/aircraft which can cause large-scale terrorism  3. The sum of casualties and fatalities were more than 300 for one incident (based on GTD)
Extreme-Moderate	3	The group has shown radical activities, which caused more than 100 of casualties and fatalities through their attacks (3-5 times for the number of attacks)
Moderate	2	1. The group carries out crimes and assaults to private citizens and properties but did not target military bases, major official buildings or facilities/infrastructures.  2. The total sum of casualties and fatalities were less than 100 for 3-5 attacks
Not much related with nuclear issues	1	Nationalists, Fascists, Communists, Racists, Environmentalists, any groups whose their activities/intentions are not much related with threatening nuclear facilities and theft of such materials * Required to read the text of TOP database and do extra research about the organization. The final score will be verified later by panel of experts.

The scores of the last sub-indicator, Terrorist Capabilities, was computed with three items from the TOP database: Whether the group was active or not in recent twenty-five years (Activity throughout 25 years), Presence of Alliances, and Financial Assistance. The total sum of each scores for three items was recorded as the score of a terrorist group's capability.

#### 3.2 Sabotage Possibilities

This indicator has only one sub-indicator at this point,

which is 6.4.1.1) Incidents Occurrence Frequency. The total number of incidents occurred from 1990 to 2013 GTD database was scored from 0 to 4; the higher score indicates the less number of incidents occurred for that period.

Due to the confidential characteristic of security information, this category had much more difficulties to find sub-indicators, data of which could not be collected from open sources. But few more sub-indicators are under consideration as a proxy, and if the more data refinement is completed like previous indicators, that will be used as another sub-indicator to measure sabotage possibilities.

### 3.3 Other Methods for Completion of Framework

A survey using Analytical Hierarchy Process (AHP) was conducted to determine relative weight ratio for each category of the assessment framework. The survey was composed of three questions. Two of those are asking to give a score for each category in a rearranged frame, from 1 (the least important) to 5 (the most important), and for the pairwise comparison sets. The last one asks for a subjective answer to assign weight for all four categories. (The survey was given to a group of experts who were attending *Nuclear Security Global Expert Group meeting*).

Figure 1 shows the results of correlation analysis between the GTI scores [6] and the results of country-specific risk assessment from this study. The observed high correlation verifies the reliability of the refined data related to factors of terrorism developed in this study.

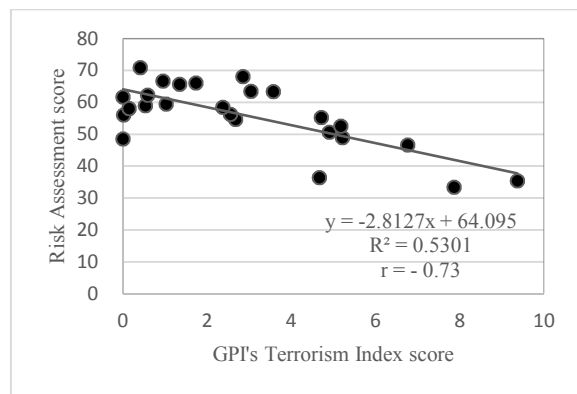


Fig. 1. Correlation between GPI's Terrorism Index and the new category Risk Assessment

## 4. Summary

The objective of this research was to enhance state-level nuclear security evaluation by focusing on the better description of risk assessment. The current assessment framework of NTI was reconstructed by re-designing a new category, Risk Assessment. Results of country-specific risk assessment from this

study showed high correlation with the Global Terrorism Index (GTI) data implying validity of the results. Results of the AHP survey to assign relative weight ratio for rearranged setup of framework will be further examined in the future work.

Regression analysis with other variables and sensitivity test by differentiating weight factors of each of the indicators and categories will be performed in the future as well.

## REFERENCES

- [1] Nuclear Threat Initiative. *NTI Nuclear Materials Security Index 2<sup>nd</sup> edition* "Building a Framework for Assurance, Accountability, and Action". Washington, DC.
- [2] C. Myers. "Quantitative Methodology for Assessing State-Level Nuclear Security Measures." Doctoral dissertation, Texas A&M University, 2012.
- [3] C. Myers, W. Charlton, D.G. Ford, "Risk Analysis and Management of State Nuclear Security Measures." Presentation at the Annual Meeting of the Institute of Nuclear Materials Management, Baltimore, MD, July 11-15, 2010.
- [4] Terrorist Organization Profile. Web. Jan 4, 2015.
- [5] National Consortium for the Study of Terrorism and Responses to Terrorism (START). *Global Terrorism Database*. University of Maryland.
- [6] Vision of Humanity. *Global Terrorism Index Report 2014*. Institute for Economics & Peace. Web. Mar 3, 2015.