Feasibility Examination of ROK's Military Countermeasures against North Korean Nuclear Weapons Threat

Young A Suh[a], Man Sung Yim [a*]
[a] *Nuclear Environment & Nuclear Security Lab, Department of Nuclear and Quantum Engineering, Korea Advanced Institute of Science and Technology, 305-701, Guseong-dong, Yuseong-gu, Daejeon, Korea*
[*] *Corresponding author: msyim@kaist.ac.kr*

1. Introduction

The objective of this paper is to provide a review of the Republic of Korea's possible military countermeasures against North Korea's continuing nuclear weapons threat. For example, with growing provocations on the part of North Korea (i.e., 9 September 2016, 5th nuclear test of North Korea), the South Korean government decided to deploy a Terminal High Altitude Area Defense (THAAD) system [1] as a measure of defense against North Korea's nuclear weapons. However, this decision also caused a heated debate amongst Koreans and vis-à-vis China. The possibility of such deployment being a prelude to an American invitation to South Korea to be a partner in its ballistic missile defense system is also mentioned [2]. Some domestic parties have also argued that ROK's nuclear armament ambitions are valid in light of the uncertainty in the Trump administration's foreign policy. This assertion may have been prompted by the observation that two-thirds of South Koreans [3] being receptive toward possessing nuclear weapons [4]. While the government of ROK is firmly committed to nuclear nonproliferation, such survey results are raising concerns in the international community.

A related question to ask in this situation is: "Which ROK countermeasure strategies would be most relevant in dealing with North Korea's nuclear capabilities?" To answer this, we developed a list of possible countermeasures and discussed their political ramifications to the ROK. From these considerations, seven different options were selected to analyze the feasibility of each option based on cost-benefit comparisons. Due to the very uncertain nature of the exercise involved, the Fuzzy logic method was employed in the analysis. In the assessment, three main factors were considered: 1) Costs; 2) Direct impact on ROK domestic economy; and 3) Impact on ROK national security. Foreign policy changes by the major powers toward the ROK are considered as part of Factor 2) and 3). Potential impact of ROK's countermeasure decisions on North Korea's national strategy was not considered in the current analysis as the DPRK's Economy-Nuclear Parallel Policy is not likely to change due to ROK's influence.

2. ROK's Possible Countermeasure Strategies

The possible countermeasures initially assumed to address the North Korean nuclear threat by the ROK included; 1) Development of Kill chain with Korea Air and Missile Defense (KAMD); 2) THAAD deployment from the US; 3) Construction of nuclear Bombproof shelter (Fallout shelter); 4) Securing U.S. nuclear umbrella; 5) Reintroducing American tactical nuclear weapons; 6) Nuclear Sharing with NATO; 7) Nuclear hedging with Japanese style of developing full nuclear fuel cycle (NFC) capabilities; 8) Developing own nuclear weapons; 9) Purchasing nuclear weapons in a black market while employing Israeli style "Neither Confirming, Nor Denying (NCND)" strategy[5]. Each of these scenarios has advantages and disadvantages. But most importantly, the selected option should come with the capability of providing either a complete nuclear passive deterrence (an effective Missile Defense System (MDS)) or a complete active deterrence (retaliatory power) to qualify as a meaningful military countermeasure. Based on this consideration, seven strategies were examined through feasibility analysis, including the status-quo. It was assumed that the U.S. nuclear umbrella currently exists in the ROK as the status-quo. Then the options examined were: 1) Maintenance of the status quo (Securing U.S. nuclear umbrella); 2) deployment of THAAD 3) Additional Implementation for a complete Missile Defense System (MDS) comprised of Kill-chain, Korea Air and Missile Defense (KAMD) and THAAD; 4) Introducing American tactical nuclear weapons and completing MDS; 5) Nuclear sharing with the U.S. + completing MDS; 6) Forming a strategic alliance for nuclear sharing with the France or the U.K in exchange for spent fuel reprocessing + completing MDS; and 7) Development of domestic nuclear weapons. These seven scenarios are summarized in Table 1 and further discussed below.

Table 1. Details of what is included in the countermeasure scenarios

	The Status-Quo: Scenario 1	THAAD: Scenario 2	KAMD+THADD: Scenario 3	US Tactical Nuclear Weapons: Scenario 4	Nuclear Sharing with the US: Scenario 5	Nuclear Sharing with France/UK: Scenario 6	ROK Nuclear Weapons: Scenario 7
U.S. nuclear umbrella	O	O	O	O	O	Δ	X
THAAD deployment	X	O	O	O	O	Δ	X
Developing Kill-Chain & KAMD	X	X	O	O	O	O	O
America tactical nuclear	X	X	X	O	O	X	X

weapons							
Nuclear sharing with the U.S.	**X**	**X**	**X**	**X**	O	X	X
Nuclear sharing with France or the UK	**X**	**X**	**X**	**X**	X	O	X
Domestic nuclear weapon development	**X**	**x**	**X**	**X**	X	X	O
The ROK's nuclear deterrence	S	P	P	VP	VP	VP or P	P

2.1. Maintenance of the status quo (U.S. nuclear umbrella)

This scenario can be a reference case for comparison with the other options. According to an official joint declaration at the Korea U.S. Security Consultative Meeting (SCM) [6], the ROK has been protected by the U.S. Nuclear umbrella. It is one of 'negative security assurance', which is guaranteed by a nuclear weapon state (the U.S.). This current option has the benefit of: 1) Confirming the validity of bilateral treaty between the U.S. and ROK, 2) Providing powerful nuclear revenge capability of the U.S., 3) Improving the reliability of ROK's customized deterrence strategy (Table Top Exercise: TX), and 4) Requiring no additional costs. However, some argue that with the uncertainty in the Trump Administration's foreign policy, this option is not secure.

2.2 Deploying a THAAD system

Recently, the ROK deployed the THAAD system which is anti-ballistic missile system in their terminal phase using a hit-to-kill approach against North Korea missiles. As a result, China currently expresses dissatisfaction of this option by economic retaliations. Due to the incomplete nature of this approach in defending against DPRK nuclear threats, the needs for additional countermeasures are also brought up.

2.3. Completion of Missile Defense System (MDS)

This scenario requires the implementation of a Korea Air and Missile Defense (KAMD) program and a Kill-chain system for the preemptive action against NK nuclear weapon attacks. The program's effectiveness is enhanced by including a THAAD system, enabling a complete passive nuclear defense, while. This option can increase the possibility of effective defense due to its defense in depth nature (covering both 'before' and 'after launching the missile').

Even if the cost of THAAD is paid by the U.S., the cost for other systems (KAMD and Kill-chain) is to be paid by the ROK government. The capital investment for building the Kill-chain and KAMD is estimated **at $2.8 billion/year** including a 10 year R&D period. Annual operating and maintenance costs are estimated to be $14.2 million/year for reinforcing troops and $9.9 million/year for maintaining strength [7].

Implementation of this option may imply damage to the ROK-China relations and additional cost to the ROK due to economic retaliations by China.

2.4. Completing MDS & Introducing American Tactical Nuclear Weapons

In the case of Scenario 3, the associated cost will be similar to that of Scenario 2, except for the addition of maintenance costs incurred by tactical nuclear weapons and the required armed forces personnel. However, this option presents the synergy between passive and active deterrence. This option also presents a dramatic warning capability against North Korea which was recently considered by the Trump administration positively, thus providing political feasibility in getting the U.S. and other allies' consent. The benefits from the option include: 1) Possibility of quick retaliation; 2) Presenting dominating nuclear deterrence capability, and; 3) Comparatively a low cost option. However, this option does not provide the ROK an authority on the use of tactical weapons and violates the joint declaration of the denuclearization of Korean Peninsula implemented in 1991. This option also presents complications with China or Russia as these countries are worrisome about the expansion of the U.S influence and increased potential for nuclear war in Korean Peninsula.

2.5 Nuclear Sharing with the U.S.+ Completing MDS

Nuclear sharing is a concept in NATO's policy of nuclear deterrence. It involved the member countries without nuclear weapons of their own in the planning for the use of nuclear weapons by NATO, and in particular provides for the armed forces of these countries to be involved in delivering these weapons should the use of the weapons is necessary. Advantages of this option include: 1) having an authority for the use of nuclear weapon 2) maintaining and developing technical equipment required for the use of nuclear weapons (including warplanes capable of delivering them), and 3) storing nuclear weapons on the country's territory. Even though some *critics inside NATO* argue that this option violates Articles I and II of the Nuclear Non-Proliferation Treaty (NPT), Belgium, Germany, Italy, the Netherlands and Turkey are hosting U.S. nuclear weapons as part of NATO's nuclear sharing policy until now [8] Adopting this nuclear sharing as part of the US-ROK alliance can be considered. This option implies potential conflicts with China and perhaps with Russia.

2.6. Nuclear sharing with France or the UK in exchange for spent fuel reprocessing

As an alternative to nuclear sharing with the U.S., nuclear sharing with either France or the UK could be considered. If France or the UK can be persuaded to participate in nuclear sharing with the ROK, an active

deterrence program can be put in place against North Korea's nuclear weapons program. One possible way for this cooperation to proceed would be awarding France or the U.K. the overseas spent fuel reprocessing services contract in exchange for nuclear sharing. Advocating the cooperation between middle power countries may be appealing to strengthen alliance for ROK's security. This option also presents the benefit of addressing key issue in spent fuel management in the ROK.

2.7 Domestic Nuclear Weapons Development

Developing ROK's own domestic nuclear weapons capability has been suggested driven by the populist view of domestic politics. This option includes activities ranging from acquiring fissile materials (through spent fuel reprocessing or uranium enrichment) to developing delivery devices. This scenario is focused on strengthening only active deterrence (retaliatory power). The most salient benefit of this option is having a definite nuclear deterrence countermeasure. By completing a full nuclear fuel cycle, technological capabilities of the ROK might enhance to the next level. However, there are also major drawbacks including: 1) Violation of the NPT; 2) Anticipated economic sanctions from the international community and the UN; 3) Increase in security vulnerability due to weakening of alliance between ROK-U.S.; 4) Increasing the risk of nuclear war; and 5) High cost.

A previous study [7] estimated the cost of developing nuclear weapons (including the cost of building reprocessing infrastructure and delivery system for ballistic missile) based on the U.S. experience. Unfortunately, the database used for that purpose may not be relevant to the ROK as America's first efforts to study and produce nuclear weapons are probably not the best model to use when starting a weapons production program today. To overcome this weakness, a cost-estimation approach for assimilating the ROK situation into other nuclear-armed nations was used. This economic cost prediction model also includes an amalgam of data from nuclear-armed nation's databases (i.e., China, the U.S., the U.K, France, Russia, India, Israel, Pakistan and North Korea). These databases cover the details on military spending, GDP and imports & exports. By using these databases, it was estimated that the Republic of Korea would spend around **$4 billion** per year to support a nuclear weapons development program. Some experts argued that it will take only 6 months to 1 year to build nuclear weapons by using the laser uranium enrichment method (having a successful experience in 2004). Even if it takes a long time for building an infrastructure (reprocessing or enrichment facility), many researchers estimated that the R&D period will not exceed 5 years. This cost estimation however does not consider the impact of economic sanctions which will be very large as the ROK economy mainly relies on foreign trade. The cost may even become higher as the option would result in deterioration of ROK-US alliance.

3. International Reactions to the Possible Scenarios

As mentioned before, each scenario has to be assessed with respect to not only the costs of policy implementation, but also national security and domestic economic damage implications. To evaluate these, we should form the basis of foreign policy change by the major powers toward the ROK. Thus, this study postulated possible international responses to each of the seven scenarios as summarized in Table 2. This study chose the member states from six parties (the U.S., China, Russia, Japan, ROK and North Korea) along with the U.N., and considered their potential reactions to each of the decisions represented in the seven scenarios. For example, the current ROK action in deploying the THAAD is strengthening the alliance with the US, but have a strongly negative effect on the relationship with China incurring retaliatory actions by China (i.e., prohibition of tourism or imports, shutting down Korean brand retail stores, banning concerts by Korean artists and pop singers, etc.). In addition, some are concerned about the recovery of North Korea-China relationship which might have a negative influence on the ROK national security. In the case of Russia, they rhetorically implied an unfriendly stance against the ROK possibly for the balance of power in Northeast Asia. With these observations, we estimated the approximate cost of economic sanctions from China and Russia based on the size of current bilateral economic trade. Potential impact of the degradation of Sino-ROK or Russia-ROK relations on ROK national security was also assessed. Results of these assessment are for all of the scenarios summarized in Table 2.

Section 4 describes how the results are processed to assess the feasibility of each scenario.

Table 2. Summary of International Reactions toROK's Possible Nuclear Strategies

Foreign policy change by major powers toward the ROK								
US	**SI(3)**	S	P	P	VP	VP	N or S	VN
	EI (1)	S	S	S	S	S	N or S	VN
China	**SI (1)**	S	N	N	VN	VN	VN or N	VN or N
	EI (2)	S	N	N	VN	VN	VN or N	VN or N
Russia	**SI (0.5)**	S	N or S	N or S	VN or N	VN or N	VN or N	VN or N
	EI (0)	S	S	S	S	S	S	S
Japan	**SI (1)**	S	S	S	S	S	N or S	VN
	EI (1)	S	S	S	S	S	N or S	VN
The UN or IAEA	**SI (0)**	S	S	S	S	S	S	S
	EI (3)	S	S	S	S	S	S	VN
Total Impact on the ROK situation								
1) The cost of policy Implementation		Medium	Medium	High	High	High	High	Very High - High
2) National security damage		Small	Small	Small	Small	Small	Medium	Large
3) Domestic		Very	Small	Smal	Mediu	Mediu	Small-	Very

economy damage	Small		l	m	m	Large	Large

* Security Impact (SI)/ Economic Impact (EI)/ Negative effect (N)/ Very Negative effect (VN)/ Positive effect (P)/Very Positive effect (VP)/Status quo (S)

4. Feasibility Analysis on the Six Scenarios using Fuzzy logic

The Fuzzy logic is a form of many-valued logic in which the truth values of variables may be any real number between 0 and 1 [9]. Fuzzy logic has been employed to handle the problem's ambiguity and uncertainty, focusing on the possibility (range between completely true and completely false), not the probability. This study considered three key factors for each scenario including cost, impact on ROK's national security, and economic impact of the major power's reactions. The values assessed for the three factor for the countermeasure scenarios were represented as fuzzy numbers and processed to derive the output to capture the feasibility of the respective scenarios. The output to capture the feasibility of each scenario was represented as the possibility of practical policy implementations. For this purpose, this study developed forty-five fuzzy knowledge rules for the given set of fuzzy numbers. The output then becomes the average of the sum of the values of the three factors. It was assumed in the calculation that all three factor carry equal weights. Table 3 summarizes the results of the fuzzy logic simulation.

Table 3.The Results of Fuzzy Logic Simulation

	Cost	**Security Damage**	**Economic Damage**	**Possibility of practical policy implementations**	
Scenario 1	Medium	Small	Very Small	0.916	Very High feasibility
Scenario 2	Medium	Small	Small	0.886	Very High feasibility
Scenario 3	High	Small	Small	0.727	High feasibility
Scenario 4	High	Small	Medium	0.689	High feasibility
Scenario 5	High	Small	Medium	0.689	High feasibility
Scenario 6-1	High	Medium	Small	0.504	Middle feasibility
Scenario 6-2	High	Medium	Large	0.443	Middle feasibility
Scenario 7-1	High	Large	Very Large	0.083	Very Low feasibility
Scenario 7-2	Very High	Large	Very Large	0.083	Very Low feasibility

As shown in Table 3, developing ROK's own nuclear weapons is assessed to have a very low feasibility. The status-quo or deploying THADD were assessed to be a very high feasibility option. Implementation of missile defense along with THADD was the next preferable option. Reintroducing tactical nuclear weapons from the U.S. or nuclear sharing with the U.S. were both found to be highly feasible. Interestingly, when comparing with Scenario 1 and Scenario 2, it can be seen THAAD deployment is a good choice for strengthening the nuclear deterrence despite the economic damage due to China's retaliation.

5. Conclusion

In this study, the scenarios of the ROK countermeasure strategies against North Korean nuclear threat was developed and compared. The comparison was based on feasibility analysis using the Fuzzy logic. Results indicated that ROK's own nuclear weapons development is not a desirable option. Other options such as completed MDS, American tactical weapons, and nuclear sharing with the U.S might be feasible while maintaining the US-ROK alliance and experiencing some impact on economic trade.

ACKNOWLEDGEMENT

THIS RESEARCH WAS SUPPORTED BY BK21 PLUS, KAIST, KOREA.

REFERENCES

[1] BBC News, "US and South Korea agree THAAD missile defense deployment", BBC News, 8 July 2016 Available at: http://www.bbc.com/news/world-asia-36742751 (Access on 3 Feb. 2017)

[2] J.S. Johnson, The US-China Military and Defence Relationship during the First Obama Administration 2009-2013: Deteriorating Military Relations in the Asia Pacific, Washington's Strategic and Military Responses and Security Dilemma Explanations. Diss. Department of Politics and International Relations, 2017.

[3] J. Feffer, "Should South Korea Get the Bomb?" The Hankyoreh, April 6, 2016, Available at: http://english.hani.co.kr/arti/english_edition/e_editorial/738448.html

[4] The Asan Annual Survey, 2010-2014; The Asan Daily Poll, July 2014

[5] T. W. Kim, "The ROK's Nuclear Armament and the Pros and Cons of diplomacy, economy and security aspects", 2017 KNPS-APLN Conference on 'The Trump Administration's Nonproliferation and the Korean Peninsula', 15 Feb 2017.

[6] U.S. Department of Defense, Joint Communiqué of the 48th U.S.-ROK Security Consultative Meeting, Washington, D.C., October 20, 2016. Available at: https://www.defense.gov/Portals/1/Documents/pubs/USROKSecurityJointCommunique2016.pdf

[7] Y.A. Suh and M.S. Yim, "Examination of Economic Feasibility of Nuclear Weapons in the Republic of Korea", 2015 KNS spring conference paper, May 2015.

[8] Chalmers, M., & Lunn, S. (2010). NATO's tactical nuclear dilemma. Royal United Services Institute (RUSI) Occasional Paper, 16.

[9] Klir, G., & Yuan, B. (1995). Fuzzy sets and fuzzy logic (Vol. 4). New Jersey: Prentice hall.