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THESIS

**ROKN'S NUCLEAR-POWERED SUBMARINE
ACQUISITION**

by

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March 2020

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ROKN'S NUCLEAR-POWERED SUBMARINE ACQUISITION

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Submitted in partial fulfillment of the
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ABSTRACT

This thesis analyzes the Republic of Korea Navy's (ROKN) Anti-Submarine Warfare (ASW) objectives, the technical evaluation of ASW assets, and the consequences of the ROKN acquisition of possible nuclear-powered submarines. It looks at the Northeast regional maritime security environment related to submarines and the Republic of Korea's (ROK) security environment, the ROKN's objectives, and comparisons of various ASW platforms. Then, the thesis analyzes these data to weigh possible options for the ROKN to enhance its capabilities to achieve its objectives. Also, it explores possible consequences of the ROKN's nuclear-powered submarines acquisition with North Korea, China, and the United States. It concludes that the ROKN's capabilities will increase to achieve its objectives through the acquisition, but the ROK will face obstacles and harsh consequences after the acquisition, which will arise between China and North Korea, and before the acquisition, which will arise between the United States, in nuclear-powered submarines acquisition.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADM	Admiral
AIP	Air Independent Propulsion
ASW	Anti-Submarine Warfare
DoD	Department of Defense
DOE	Department of Energy
DPRK	Democratic People's Republic of Korea
DSME	Daewoo Shipbuilding and Marine Engineering
FTA	Free Trade Agreements
HEU	High Enriched Uranium
IAEA	International Atomic Energy Agency
ICBM	Intercontinental Ballistic Missile
LCDR	Lieutenant Commander
LEU	Low Enriched Uranium
MND	Ministry of Defense
MPRA	Maritime Patrol Reconnaissance Aircraft
NATO	North Atlantic Treaty Organization Northern
NLL	Limit Line
NPT	Non-Proliferation Treaty
PLAN	People's Liberation Army Navy
PRC	People's Republic of China
ROK	Republic of Korea
ROKN	Republic of Korea Navy
SLBM	Submarine Launched Ballistic Missile
SLOC	Sea Line of Communication
SONAR	sound navigation and ranging
SSB	Diesel-Electric Ballistic Missile Submarine
SSC	coastal submarine

SSG	Diesel-Electric Guided Missile Submarine
SSM	midget submarine
THAAD	Terminal High Altitude Area Defense
UN	United Nations
U.S.	United States
USN	United States Navy

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I. INTRODUCTION

A. MAJOR RESEARCH QUESTION

In 2017, Republic of Korea (ROK) president Moon Jae-In ordered an analysis of the feasibility of acquiring nuclear-powered submarines.¹ The ROK has been enhancing its Anti-Submarine Warfare (ASW) capabilities via acquiring ASW helicopters and Maritime Patrol Reconnaissance Aircrafts (MPRAs) and manufacturing destroyers and diesel-electric submarines to reduce enemies' submarine threat in the vicinity of its maritime area. It also recently announced the purchase of six P-8A Poseidon class MPRAs,² and commissioned the newest 3750-ton *Dosan Ahn Changho* class diesel-electric submarine.³ However, ROK president Moon wants submarines that can stay underwater longer in order to counter the North Korean submarine launched ballistic missile (SLBM) threat.⁴ In that regard, would the ROKN's acquisition of nuclear-powered submarines enhance the ROKN's abilities to accomplish its objectives of neutralizing the North Korean submarine threat?

According to ADM Richardson, the U.S. Chief of Naval Operation, "the Navy must be able to operate with sufficient numbers of the right kinds of capabilities to attack, deceive, and defend against adversary missiles, submarines, and cyber and electronic attack."⁵ Out of all the threats that ADM Richardson listed, the submarine is the only

¹ Timothy Ketter, *Anti-Submarine Warfare in the 21st Century* (Newport, RI: Naval War College, 2004).

² Christine Kim and Joyce Lee, "South Korea picks Boeing P-8 for \$1.7 billion maritime patrol aircraft contract," *Reuters*, 25 June 2018, <https://www.reuters.com/article/us-southkorea-military-procurement/south-korea-picks-boeing-p-8-for-17-billion-maritime-patrol-aircraft-contract-idUSKBN1JL0V7>.

³ Franz-Stefan Gady, "South Korea Launches First-of-Class 3,000-ton KSS-III Diesel-Electric Attack Submarine," *The Diplomat*, 14 September 2018, <https://thediplomat.com/2018/09/south-korea-launches-first-of-class-3000-ton-kss-iii-diesel-electric-attack-submarine/>.

⁴ Jeff Jeong, "South Korea Eyes French Design for Indigenous Nuclear Sub, Sources Say," *Defense News*, March 28 2018, <https://www.defensenews.com/industry/techwatch/2018/03/28/south-korea-eyes-french-design-for-indigenous-nuclear-sub-sources-say/>.

⁵ John Richardson, "CNO White Paper: 'The Future Navy'," *Proceedings* 143, no. 7, <https://www.usni.org/magazines/proceedings/2017/july/cno-white-paper-future-navy>.

platform that he called out specifically because it is the most capable vessel that can carry out deadly missions covertly. ADM Richardson also listed three threats—China, Russia, and North Korea—whose common development is also submarines.⁶ In this context, it is not hard to appreciate why the ROK, a neighbor to China, Russia, and North Korea, might have an interest in developing and enhancing ASW capabilities to neutralize its adversaries' submarine threats.

B. SIGNIFICANCE OF THE RESEARCH QUESTION

The analysis in this thesis of the ROKN's acquisition of nuclear-powered submarines will not only evaluate the ROKN's abilities to accomplish its objectives, but it will also investigate how the ROK's advanced military equipment acquisition affects the ROK's and the Northeast Asian region's security environment. Additionally, the analysis on the acquisition will reveal the relationships between national threats, strategic objectives, and military objectives.

As China gains economic power to become one of the great powers in the region, it is raising its military strength as well as its capabilities to expand its influence. As a result, Japan has initiated an increase in military capabilities to defend itself from a future Chinese threat in the region.⁷ Also, the ROK's decision to examine the possibility of acquiring nuclear-powered submarines is partially influenced by the Chinese naval expansion, and it is largely due to North Korea acquiring Submarine Launched Ballistic Missile (SLBM) capability.⁸ Through examining the consequences of the ROK's nuclear-powered submarines acquisition in the region, this thesis will not only analyze the regional security environment and these countries' dynamics, but it will also show how the ROK's acquisition may affect the ROK-U.S. relationship.

⁶ Richardson, "CNO White Paper: 'The Future Navy'."

⁷ Tara Copp, "Japan surges new weapons, military roles to meet China's rise," *Military Times*, 15 January 2019, <https://www.militarytimes.com/news/2019/01/15/japan-surges-new-weapons-military-roles-to-meet-chinas-rise/>.

⁸ Franz-Stefan Gady, "Will South Korea Build Nuclear Attack Subs?," *The Diplomat*, 8 November 2017, <https://thediplomat.com/2017/11/will-south-korea-build-nuclear-attack-subs/>.

The United States has been paying much of its attention to the East Asian region, as evidenced by the Pivot to Asia policy, in order to check China's power in the region. Also, President Trump's policies toward North Korea demonstrate that the United States still has much at stake in the region's security and in reducing the North Korean threats.⁹ Since the ROK-U.S. relationship influences how the ROKN achieves its objectives, analyzing possible reactions by the United States regarding the ROK's acquisition of nuclear-powered submarines will offer new insights into how the ROK relationship with the United States and the United States's recent amendment of the 123 Agreement with the ROK.¹⁰

Acquiring a new technology that is beyond a country's capacity does not always work out. For example, in 1972, North Korea purchased sophisticated heavy industry equipment to develop its economy, but its plan did not succeed because these manufacturing machines were too advanced for the North Korean workers and North Korea's supporting infrastructure was too outdated.¹¹ Therefore, a careful analysis is important before a country commits to a new technology or equipment.

Researching this thesis question will provide useful analysis for any country that is considering acquiring nuclear-powered submarines. Therefore, if a country were to acquire a nuclear-powered submarine, this thesis would provide a helpful reference with regard to acquisition of a nuclear-powered submarine. Also, this research will provide advantages and disadvantages of acquiring a nuclear-powered submarine; hence, one can comprehend the ROK's desire for acquisition of nuclear-powered submarines.

There are a few prior studies mentioning the ROK's acquisition of nuclear-powered submarines in national security perspective, cost perspective, and non-proliferation

⁹ Mitch Lerner, "Where the US Went Wrong on North Korea", *The Diplomat*, 6 Sep 2018, <https://thediplomat.com/2018/09/where-the-us-went-wrong-on-north-korea/>; Markus B. Liegl, "Maximum pressure—deferred engagement: why Trump's North Korea policy is unwise, dangerous, and bound to fail," *Global Affairs* 3, nos. 4-5 (2017), 365–377, 374, <https://doi.org/10.1080/23340460.2017.1416791>.

¹⁰ Fred McGoldrick, *The New Peaceful Nuclear Cooperation Agreement Between South Korea and the United States: From Dependence to Parity* (Washington, DC: Korea Economic Institute, 2015), 37.

¹¹ Michael J. Seth, *A Concise History of Modern Korea: From the Late Nineteenth Century to the Present* (Maryland: Rowman & Littlefield, Lanham, 2010), 156.

perspective. However, there has not been a study that solely looks at this issue, comprehensively combining all perspectives and linking them together. Looking at analysis of the major issues in important areas such as domestic and foreign policies, regional security stability, allies' relationships, and nuclear-powered submarines operation complexities, which will affect the ROKN and the ROK military's objectives, will reveal both how these issues are intertwined and influence both the ROK and the region.

C. LITERATURE REVIEW

Since the idea of the ROK's acquisition of nuclear-powered submarines recently emerged in 2017, there are not many scholarly articles regarding the topic. There are only a few articles that have analyzed the topic academically, and there are several articles reporting facts of the ROK government's intention and recent developments. Those few analytical works have offered different assessments of the wisdom of ROKN acquisition of nuclear submarines. Thus, this literature review provides background information on the research question as well as reviewing current viewpoints within the scholarly articles available related to the research question.

In order to understand the research question better, it is important to know basic information regarding the ROKN's objectives for acquiring a nuclear-powered submarine. According to the ROK Ministry of Defense White Paper, its objectives for 2018 are protecting the nation from external threats and invasion, support for peaceful reunification, and promoting regional peace and contribution to world peace.¹²

Reasons for the ROK government to acquire nuclear-powered submarines are related to its national security concerns. Lami Kim states that the ROK's primary reason behind its motivation for nuclear-powered submarines is to stay underwater longer than permitted by its conventional diesel submarines in order to find and destroy North Korean

¹² The Republic of Korea Ministry of Defense, *2018 Defense White Paper* (Seoul: Republic of Korea, 2018), 33–34.

submarines.¹³ She also states that, “the United States would be deterred from retaliating against North Korea, should the latter attack Seoul or Tokyo,”¹⁴ and “Trump’s continued threats to carry out preemptive strikes against North Korea make South Koreans not only worry that the United States may not trade Los Angeles for Seoul, but also worry the United States may sacrifice Seoul for Los Angeles.”¹⁵ At the same time, North Korea’s increasing erratic behavior of nuclear and missile tests only increased the ROK’s concern of its national security.¹⁶ Lastly, she states that there is a possibility of the U.S. Nuclear Umbrella not working in case of North Korea’s nuclear weapons deployment.¹⁷ Thus, the ROK is not likely to acquire nuclear weapons, but “Moon’s pursuit of nuclear-powered submarines is concerning because it may be an illustration of a nuclear hedging policy.”¹⁸ She clearly states why the ROK needs to acquire nuclear-powered submarines in national security perspective, but she does not explain possible effects and consequences which these nuclear-powered submarines acquisition will cause.

LCDR Ji-Hoon Yu, a ROKN submarine officer, and Erik French list different reasons than Lami Kim does for the ROK’s acquisition of nuclear-powered submarines. While the main reason is the threat of North Korea’s nuclear missiles and its submarines, they state that the ROK’s acquisition will strengthen the “allies’ ability to carry out the ‘4D’ operational concept. This concept emphasizes the need to ‘detect, disrupt, defend against, and destroy’ North Korean nuclear missiles.”¹⁹ They argue that the ROKN’s capabilities are limited due to short ranged and slow diesel-electric submarines, but they

¹³ Lami Kim, “South Korea’s Nuclear Hedging?,” *The Washington Quarterly* 41, no.1 (Spring 2018), 115–133, 124, <https://doi.org/10.1080/0163660X.2018.1445910>; Zachary Keck and Henry Sokolski, “South Korea Is about to Make a \$7 Billion Nuclear Submarine Blunder,” *The National Interest*, 30 September, 2017, <https://nationalinterest.org/blog/the-buzz/should-south-korea-start-building-nuclear-submarines-22480>.

¹⁴ Kim, “South Korea’s Nuclear Hedging?,” 120.

¹⁵ Kim, “South Korea’s Nuclear Hedging?,” 120.

¹⁶ Kim, “South Korea’s Nuclear Hedging?,” 120.

¹⁷ Kim, “South Korea’s Nuclear Hedging?,” 122.

¹⁸ Kim, “South Korea’s Nuclear Hedging?,” 125.

¹⁹ Jihoon Yu and Erik French, “Should South Korea Start Building Nuclear Submarines?,” *The National Interest*, 26 September, 2017, <https://nationalinterest.org/blog/the-buzz/should-south-korea-start-building-nuclear-submarines-22480>.

state that by acquiring nuclear-powered submarines, the ROKN will provide better ASW support for its fleets; thus, making the ROKN more responsive.²⁰

Another reason for the ROK's acquiring nuclear-powered submarines, according to Yu and French, is "strengthening the allies' efforts ability to engage in coercive bargaining with North Korea."²¹ They state that the ROK's acquisition of nuclear-powered submarines will also benefit the United States because it will allow the ROK to assume greater responsibility for its defense, and extend the U.S.-ROK alliance.²² Lami Kim agrees on the positive effect of these submarines in the U.S.-ROK relationship due to the ROK military's contribution to "the alliance's military burden sharing, which Trump desires."²³ While Yu and French list benefits of having nuclear-powered submarines, they fail to mention reality of having these submarines, such as costs of these submarines and the ROKN's ability to operate them.

Keck and Sokolski argue that the ROK's nuclear-powered submarine acquisition will not help strengthen the ROK-U.S. security relationship due to a possible violation of the U.S. non-proliferation restrictions.²⁴ However, Lami Kim thinks it depends on how one interprets the treaty because "the NPT addresses 'nuclear weapons or other nuclear explosive devices' and says nothing of nonexplosive uses of nuclear technologies, whether for military purposes or not."²⁵ She thinks that the ROK has a capacity to generate nuclear-powered submarines, which she calls "nuclear latency," but in her view what is more important to the ROK is its nuclear hedging, which combines such nuclear capability with the intention to go further.²⁶ While the ROK government thinks that low-enriched uranium powered submarines will not violate the NPT, Kim does not agree with the Korean government on this issue.

²⁰ Yu and French, "Should South Korea Start Building Nuclear Submarines?"

²¹ Yu and French, "Should South Korea Start Building Nuclear Submarines?"

²² Yu and French, "Should South Korea Start Building Nuclear Submarines?"

²³ Kim, "South Korea's Nuclear Hedging?" 128.

²⁴ Keck and Sokolski, "South Korea Is about to Make a \$7 Billion Nuclear Submarine Blunder."

²⁵ Lami Kim, "South Korea's Nuclear Hedging?" 126.

²⁶ Lami Kim, "South Korea's Nuclear Hedging?" 126.

According to Kim, the ROK government's uncertain intention of having "the option of developing nuclear weapons by building nuclear-powered submarines (nuclear hedging)"²⁷ may violate the NPT due to the technology inherent in the nuclear-powered submarines' reactors.²⁸ Yu and French also point out the problems with safeguarding nuclear materials if the ROK were to acquire nuclear-powered submarines. They agree with Lami Kim that the reactor technology "could be utilized for nuclear weapons,"²⁹ but they think that the technology "can strengthen states' mastery of the nuclear fuel cycle and can pave the way for a latent nuclear capability."³⁰ Keck, Sokolski, and Kim also discuss the nuclear-powered submarines effects in the ROK-U.S. relationship, but they do not mention the submarines effects in the regional security stability.

Zachary Keck and Henry Sokolski argue that acquiring nuclear-powered submarines is too expensive for the ROKN, and a cheaper and easier option for the ROKN to achieve its objectives is to use other ASW platforms, such as a MPRA, because a nuclear-powered submarine costs from \$2 billion to \$2.5 billion, which is much more than a MPRA.³¹ On top of the nuclear-powered submarines' cost, these submarines require a special navy base to perform maintenance and to house and protect the submarines. For example the cost of a special nuclear-powered submarine base for Brazil³² will be around \$2.1 billion.³³ While Keck and Sokolski show the nuclear-powered acquisition costs, they do not present cost of the MPRA or other alternative options in place of the nuclear-powered submarines.

Additionally, Yu and French argue that it would be difficult to convince North Korea to denuclearize its nuclear programs if the ROK were to acquire nuclear related

²⁷ Kim, "South Korea's Nuclear Hedging?" 126.

²⁸ Kim, "South Korea's Nuclear Hedging?" 126.

²⁹ Yu and French, "Should South Korea Start Building Nuclear Submarines?"

³⁰ Yu and French, "Should South Korea Start Building Nuclear Submarines?"

³¹ Keck and Sokolski, "South Korea Is about to Make a \$7 Billion Nuclear Submarine Blunder."

³² Brazil is used as a comparison due to its similarity in national GDP, length of coastline, the U.S.'s ally, and as a democratic country.

³³ Keck and Sokolski, "South Korea Is about to Make a \$7 Billion Nuclear Submarine Blunder."

military equipment,³⁴ and it may lead other countries in this region to grasp latent nuclear capabilities.³⁵ Therefore, it will only increase regional security instability and make it difficult for the ROKN to achieve its objectives.

Since the ROK's interest in acquiring nuclear-powered submarines is recent, there is not much data regarding this topic. The preceding literature review shows that many works thus far only deal with one specific area at a time. There is not a study examining the ROK's acquisition of nuclear-powered submarines comprehensively. When it comes to analyzing a country's naval objectives and national security, one cannot simply look at one individual element influencing its objectives or national security matters. These issues that affect one's national security are usually interconnected and intertwined. For example, a country's foreign policy is intertwined with economic, social, historical, and national security issues. Therefore, this thesis will link important elements and effects due to the ROK's nuclear-powered submarines acquisition plans in order to analyze how well the ROKN would achieve its objectives if it were to acquire nuclear-powered submarines.

D. POTENTIAL EXPLANATIONS AND HYPOTHESES

Even though the ROKN's acquisition of nuclear-powered submarines may enhance its capabilities, a further analysis is required to conclude whether this would advance the ROK's broader security interests, because its acquisition of nuclear-powered submarines is intertwined with other issues in the East Asian regional security stability. The ROK's ability to achieve its objectives would depend on how acquisition of nuclear-powered submarines might influence the ROK military's budget, regional security stability, and the relationships in the Northeast Asian countries and the United States.

This thesis will assess whether or not the acquisition of nuclear-powered submarines would serve the ROK's national security objectives in the broadest sense, beyond the specific advance of the ROKN's capabilities that acquisition would represent.

³⁴ Yu and French, "Should South Korea Start Building Nuclear Submarines?"

³⁵ Yu and French, "Should South Korea Start Building Nuclear Submarines?"

E. RESEARCH DESIGN

This thesis research will employ a simplified version of process-tracing to identify the most important external security motivations behind ROK governmental thinking concerning nuclear-powered submarine acquisition. The thesis will then compare that option to other options in terms of satisfaction of ROK national security goals, utilizing a broader array of quantitative measures than prior studies. The thesis will then evaluate more qualitative criteria, including military objectives, regional security intentions, and the anticipated reactions of other key governments. Thus the thesis will process both qualitative and quantitative data in regards to the ROK's threats and objectives, the ROK's nuclear-powered submarine acquisition and other various ASW assets, and the effects of the ROK's nuclear-powered submarines acquisition, in order to develop a comprehensive and integrated analysis.

F. THESIS OVERVIEW

The thesis will start with an overview of the Northeast Asian regional security environment and the ROK's security environment to survey the threats and uncertainties against the ROK that drive the ROK's and the ROK's objectives. Then, it will evaluate technical aspects of nuclear-powered submarines, focusing on cost and sonar performance as regards the ROK's acquisition of nuclear-powered submarines. Next, it will analyze the possible consequences of the ROK's acquisition of nuclear-powered submarines for the region, relationships with other countries, and submarine proliferation. Lastly, it will review Canada's attempt to acquire nuclear-powered submarines in the 1980s as evidence to support claims of possible consequences for the ROK if it pursues a similar course.

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II. BACKGROUND ON SECURITY ENVIRONMENT

In order to evaluate if the Republic of Korea Navy (ROKN)'s nuclear powered submarines acquisition would enhance the ROKN's ability to achieve its objectives, this chapter assesses the Republic of Korea (ROK)'s security environment and the ROK's threats, which create the foundation for the ROKN's own objectives to deny threats in the ROK's maritime territory and protect the ROK's maritime trade routes.³⁶ The ROK's maritime security environment is complex because the ROK has a direct threat, North Korea, which shares its borders with the ROK, and an indirect threat, China, which supports North Korea.

The ROK Navy's specific objectives flow from broader military requirements, which themselves derive from ROK national strategic objectives in response to national level threats. The ROK's executive branch gives a direction for the ROKN to pursue military objectives, and the ROKN operates to achieve its objectives. According to Vego, “[b]ecause of its scale and complexity, a military strategic or theater-strategic objective cannot be accomplished by a single act; several intermediate steps—operational objectives—have to be accomplished to achieve such a strategic objective. ... The accomplishment of each operational objective should lead to drastic or radical change in the situation in a given declared (or undeclared) theater of operations.”³⁷ Therefore, the ROKN's strategies to deal with maritime threats would be a long term contribution to neutralize or destroy broader threats to the ROK as a whole.

³⁶ Terence Roehrig, “Republic of Korea Navy and China’s Rise: Balancing Competing Priorities,” in *CAN Maritime Asia Project Workshop Two: Naval Developments in Asia*, ed. Michael A. McDevitt and Catherine K. Lea (Washington, DC: Center for Naval Analysis, August 2012), 61–78, 62.

³⁷ Milan Vego, *Joint Operational Warfare: Theory and Practice*. 20 September 2007. Reprint, 1st ed. (Newport, RI: Naval War College, 2009), II-3.

This chapter proceeds by describing the overall Northeast Asian regional security environment and the ROK's security environment. Next, the chapter explains how the threats can be met by the ROK's submarines. The chapter then addresses how the ROKN sets its objectives to contribute to the ROK's strategic objectives using its submarine force now and in the future.

A. OVERALL REGIONAL SECURITY ENVIRONMENT

Maritime security is important to the Northeast Asian countries because maritime security provides them political, economic, and strategic securities to the Northeast Asian countries. The maritime security enables these countries—such as, China, Japan, and the ROK—to pursue their national interests in these categories. The regional security environment began to change again in the late 2000s. The United States began to focus more in the Northeast Asian region as China's economic power grew and China's military expanded. President Obama's Pivot to Asia policies in 2011 increased the United States's national interests in the Northeast Asian region and sought to stabilize the region by checking China's power.³⁸ However, President Trump's foreign policies toward Asia have included several shifts of direction when compared to President Obama's policies, which were prescriptive and proactive.³⁹ Therefore, the United States' policies in Asia have become harder to predict for states in the region. Meanwhile, North Korea's asymmetric strategies and capabilities have emerged as it provoked South Korea several times since 1999.⁴⁰

³⁸ David Shambaugh, "Assessing the US "Pivot" to Asia," *Strategic Studies Quarterly* 7, no. 2, Asia-Pacific special edition (Summer 2013), 10–19, 10.

³⁹ Sheila A. Smith, "Trump and Asia: Resources from CFR and Foreign Affairs", *Council on Foreign Relations*, 2 Nov 2017, <https://www.cfr.org/expert-roundup/trump-and-asia-resources-cfr-and-foreign-affairs>; Eliot A. Cohen, "America's Long Goodbye: The Real Crisis of the Trump Era," *Foreign Affairs* 98, no. 1 (Jan/Feb 2019), 138, <https://www.foreignaffairs.com/articles/united-states/long-term-disaster-trump-foreign-policy>.

⁴⁰ Ian Bowers, *The Modernisation of the Republic of Korea Navy: Seapower, Strategy and Politics* (Switzerland: Palgrave Macmillan, 2019), 30; "North Korea profile—Timeline," *BBC News*, 26 Apr 2019, <https://www.bbc.com/news/world-asia-pacific-15278612>.

Politically, China became an important stakeholder in this region as China has gained power, and its rise had changed the Northeast Asian region's institutions.⁴¹ For example, China began to build the South China Sea islands to protect its maritime route and minimize the United States' influence through maritime capabilities.⁴² China also saw the United States's efforts to stabilize this region as intending to contain China's influence in the region.⁴³ Accordingly China has been creating rival institutions, like the Asian Infrastructure Investment Bank (AIIB), in addition to pursuing maritime security means to decrease the United States' influence in this region.

Economic security is also important to these countries because they are export-oriented countries, and they import most of their energy resources through maritime imports.⁴⁴ The maritime security has been important to the Northeast Asian countries—China, Japan, the ROK, and Taiwan—because their economies depend on maritime trade routes. Other countries' blocking maritime trade routes is one of their biggest threats to them. Unlike European countries, the Northeast Asian countries trade through maritime routes because they are physically and economically seelocked. Japan and Taiwan are island countries, and the ROK is isolated by the Demilitarized Zone (DMZ) at the 38th parallel line. Unlike the United States and Middle East countries, the Northeast Asian countries lack natural resources with which to develop their economies. They depend heavily on maritime trade routes to import fossil fuels. China can transport its goods and energy resources through ground routes, but these routes are not as efficient and accessible

⁴¹ Brahma Challeaney, "Major Maritime powers and Their changing relationship: The United States, Europe, China, India, and others," in *Routledge Handbook of Naval Strategy and Security*, edited by Joachim Krause and Sebastian Bruns (Abingdon: Routledge, 12 Dec 2015), 328–338, 328.

⁴² Nick Bisley, "The South China Sea as Symptom of Asia's dynamic order." In *US-China Competition and the South China Sea Disputes*, edited by Huiyun Feng and Kai He, 98–115 (London: Routledge, 2018), 102.

⁴³ Nick Bisley, 103.

⁴⁴ Hongyi Lai, "Introduction: Understanding and Enhancing Energy and Maritime Security in Asia," *Asian Energy Security: The Maritime Dimension* (New York, Palgrave Macmillan, NY, 2009), 3–4, DOI 10.1057/9780230619609.

as maritime routes because China's manufacturing cities are concentrated near coasts and maritime shipping is more efficient.⁴⁵

The Northeast Asian regional strategic security environment has been shifting since the end of the Cold War because the regional security dynamics - Japan's relations with neighboring countries, the relationship between China and Taiwan, and the relationship between the North and South Korea - have been impacted by economic development and expanding military capabilities. These regional security dynamics were restrained by superpower competition during Cold War.⁴⁶ The collapse of the Soviet Union revealed these regional dynamics, and the limits of nations' capabilities to deal with these regional strategic dynamics have increased tensions in regional strategic security.

The national interests of China, Japan, the ROK, and Taiwan are to maintain maritime peace and stability in the Northeast Asian region because Northeast Asian regional maritime peace and stability are key elements to their growth.⁴⁷ Yet maritime sovereignty claims in the region are much contested. According to United Nations Convention on the Law of the Sea, a country's maritime sovereignty is defined as "Every State has the right to establish the breadth of its territorial sea up to a limit not exceeding 12 nautical miles, measured from baselines determined in accordance with this Convention."⁴⁸ However, additional establishments of maritime territories such as exclusive economic zones, which can be up to 200 nautical miles from a shoreline,⁴⁹ can conflict with maritime territorial claims among neighboring countries.

⁴⁵ Dean Cheng, "China's Pivot to the Sea: The Modernizing PLA Navy," *The Heritage Foundation*, 17 December, 2015. <https://www.heritage.org/node/10774/print-display>.

⁴⁶ Barry Buzan and Ole Waever, *Regions and Powers: The Structure of International Security* (London: Cambridge University Press, 2003), 152–154, <https://doi.org/10.1017/CBO9780511491252>.

⁴⁷ Alan Romberg, "The NORTHEAST Asian Security Environment amid leadership changes," in *The Changing Security Environment and Continuing North Korean Military Threat*, ed. Korea Institute for Maritime Strategy (Seoul: Korea Institute for Maritime Strategy, 2013), 33–56, 39.

⁴⁸ United Nations Convention on the Law of the Sea, Article 3 (2018), https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf.

⁴⁹ United Nations Convention on the Law of the Sea, Article 55 - Article 60 (2018), https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf.

The region's maritime security depends on how the region and countries evaluate their threats. Traditionally, maritime security's importance was based on the concept of seapower.⁵⁰ However, as technologies advanced, the ocean became a less effective barrier against threats because missiles and ships are able to travel longer. Another consequence of the technologies' advancement was globalization. As a result, more countries became connected through sea lines of communication (SLOC).⁵¹ Similar to how great powers use their economic capabilities to project their strategic objectives, maritime security has become a link to pursue different agendas. According to Bueger, "[f]or some actors, an issue might be primarily linked to the economic dimensions, while it is for others an issue of national security or safety."⁵² For example, maritime security for North Korea could only affect in its national security perspective while the ROK's maritime security could affect national security, economic, human security, and marine safety. Therefore, any change in the ROK's maritime security environment could influence several areas other than its national security.

B. THE ROK'S SECURITY ENVIRONMENT

The ROK began to recognize its maritime security's importance as the regional security environment changed. The ROK's maritime security became more important as its economic status reached its peak in the 1990s, the regional security environment changed due to China's rise, and the United States's influence strengthened in the region. According to Buzan and Waeber, the nearly full Soviet withdrawal from the region, a reduction in U.S. presence, the stagnant Japanese economy and China's own strong economic growth combined to leave China "freer to act without the constraint of either a fully-fledged regional balancer or heavy competitive engagement in the region by outside superpowers."⁵³ With the China's rise in the region, uncertainties grew in the regional

⁵⁰ Christian Bueger, "What is maritime security?" *Marine Policy* 53, Mar 2015, 159-164, 160, <http://dx.doi.org/10.1016/j.marpol.2014.12.005>.

⁵¹ Basil Germond, "The geopolitical dimension of maritime security," *Marine Policy* 54, Apr 2015, 137-142, 139, <http://dx.doi.org/10.1016/j.marpol.2014.12.013>.

⁵² Bueger, "What is maritime security?" 161.

⁵³ Buzan and Waeber, *Regions and Powers*, 156.

security environment because China deviated from the international order to their advantage.⁵⁴ Therefore, the ROK had to pursue stronger maritime security because China increasingly showed its maritime aggressiveness in the Northeast Asian region.⁵⁵

Additionally, the security environment between the North and South Korea changed in the 1990s because North Korea no longer had the Soviet Union's support and South Korea's military strength had begun to increase due to its economic growth. After the Soviet Union's collapse, North Korea wanted to have a similar economic support from Russia, but Russia could not afford to give the similar support to North Korea as the Soviet Union did because Russia inherited the Soviet Union's economic woes that led the Soviet Union to collapse.⁵⁶ The Soviet Union's collapse also increased the relative strength of the United States's influence in the region because there was no more bipolar order from the United States and the Soviet Union.⁵⁷ Therefore, the United States's pressure against North Korea increased due to loss of the Soviet Union's shield against the United States. Plus, China increased its economic ties with the ROK as China began to develop economically.

In this context, the ROK's naval capabilities to protect its maritime trade increased rapidly due to its economic growth, and the first civilian South Korean President, Kim Young-Sam, wanted to have a blue-water navy that could operate across the world in 1995.⁵⁸ Soon the ROKN's capabilities surpassed the North Korean navy's capabilities. The ROK was not concerned about North Korea's naval capabilities in the late 1990s because North Korea's conventional naval capabilities were no match for the ROKN's

⁵⁴ Buzan and Waeber, *Regions and Powers*, 157.

⁵⁵ Buzan and Waeber, *Regions and Powers*, 157.

⁵⁶ Andrea Matles Savada, North Korea, *North Korea: A Country Study* (Washington, DC: The U.S. Government Publishing Office for the Library of Congress, 1993), <http://countrystudies.us/north-korea/66.htm>.

⁵⁷ Mohd Noor Mat Yazid, "The Cold War, Bipolarity Structure and the Power Vacuum in the East and South East Asia after 1945," *Journal of Global Peace and Conflict* 2, American Research Institute for Policy Development (June 2014), no. 1, 121-128, 126, http://jgpcnet.com/journals/jgpc/Vol_2_No_1_June_2014/6.pdf.

⁵⁸ Bowers, *The Modernisation of the Republic of Korea Navy*, 1.

capabilities.⁵⁹ North Korea began to develop asymmetric strategies and capabilities to shape its security environment to defend the Kim regime's rule in North Korea.⁶⁰ But ROK military leaders were not concerned much about North Korea's response, so they continued to emphasize the blue-water navy capabilities.

1. North Korea's Influence

Understanding the North Korean navy's objectives and intentions would allow the ROKN to develop appropriate submarines' capacities against the North Korean navy's asymmetric capabilities. After the Korean War until 1980, the North Korean navy was superior to the ROKN in quantity and quality due to the Soviet Union's support.⁶¹ North Korea projected its naval power below the Northern Limit Line (NLL) willingly until 1980, but the North Korean navy became inferior to the ROKN in the late 1980s because the ROK's economic growth developed the ROKN's capabilities. The ROKN's naval power particularly benefitted from the ROK's growing industrial and technological strength.⁶²

Despite North Korea's weakness in economic growth, it continued to develop its military under the Kim family regime's Songgun and Byunjin policies, which are the military first policy and the simultaneous military and economic development policy. In surface naval assets, North Korea developed better weapons and missiles than before without improving vessels, but these capabilities were limited due to weaknesses in their sensors and network systems.⁶³ Plus, the ROKN's surface ships would outperform the North Korean surface ships even though the North Korean surface vessels were upgraded to equip these advanced weapon systems because the ROKN's technology advancement would be much faster and better than North Korea's.⁶⁴ In submarine assets, North Korea

⁵⁹ Bowers, *The Modernisation of the Republic of Korea Navy*, 29.

⁶⁰ Jina Kim, "Sources and Objectives of North Korea Foreign Policy," in *The North Korea Crisis and Regional Responses*, ed. Uptal Vyas, Ching-Chang Chen, and Denny Roy (Honolulu: East-West Center, 2015), 3-19, 6.

⁶¹ Bowers, *The Modernisation of the Republic of Korea Navy*, 29.

⁶² Bowers, *The Modernisation of the Republic of Korea Navy*, 29.

⁶³ Bowers, *The Modernisation of the Republic of Korea Navy*, 33-34.

⁶⁴ Bowers, *The Modernisation of the Republic of Korea Navy*, 35.

could not fund to develop better submarine capabilities, but the North Korean navy recognized the advantages of submarines due to 1) the ROKN's lack of focus in ASW, 2) difficulty in detecting submarines, and 3) the unfavorable environment for ASW in the Korean Peninsula maritime area. Therefore, North Korean navy recognized that it could achieve the North Korea's objectives more effectively with its submarines.⁶⁵

2. China's Influence

Similar to how the ROK focused on its littoral maritime security during its economic growth from the 1980s to 2000s, China did not pay much attention outside of its littoral waters until the late 1990s because China's biggest threat was Taiwan, which was supported by the United States, and no other external threats. However, after the conflict with Taiwan in 1996 and witnessing how the United States destroyed Iraq's military, which was similarly organized and equipped to the China's military, China began to update its outdated naval and military capabilities in 1996.⁶⁶ China's military spending increase between 1996 and 2015 showed that China did not want to be influenced by superior external powers in its national interests because the external influence could erode the CCP regime's legitimacy by introducing outside norms.⁶⁷ According to Eric Heginbotham, "[b]etween 1996 and 2015, China's official military expenditure increased by 620 percent in real terms, growing at an average annual rate of roughly 11 percent—faster than China's robust rate of economic growth."⁶⁸

The Chinese the People's Liberation Army Navy (PLAN) developed many naval capabilities, emphasized four areas—long range surveillance systems, anti-ship cruise missiles, greater range aircraft and ships, and larger and quieter submarines with torpedoes and cruise missiles.⁶⁹ The PLAN paid a special attention to its submarine capabilities

⁶⁵ Bowers, *The Modernisation of the Republic of Korea Navy*, 44.

⁶⁶ Eric Heginbotham, *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017* (Santa Monica: RAND Corporation, 2015), 25.

⁶⁷ Heginbotham, *The U.S.-China Military Scorecard*, 25–26.

⁶⁸ Heginbotham, *The U.S.-China Military Scorecard*, 26.

⁶⁹ Heginbotham, *The U.S.-China Military Scorecard*, 198.

because submarines gave the Chinese navy an advantage in the Taiwan and the South China Sea cases, which were key areas to China.⁷⁰ Compared to the Chinese navy's capabilities in 1996, the Chinese navy's capabilities in 2017 improved significantly because it would have an advantage in anti-surface warfare against the U.S. Navy in littoral warfare and have parity in anti-surface warfare with the U.S. Navy in open water warfare.⁷¹

C. THREATS MET BY THE ROK'S SUBMARINES

1. The Sinking of the *ROKS Cheonan*

As noted in the previous section, the ROK's naval strategy had been oriented toward a blue-water capability since the 1990s. However, the sinking of the *ROKS Cheonan* changed that orientation, and with it the direction of the development of the ROKN's capabilities. In 2010, a North Korean submarine sank the *ROKS Cheonan* with a torpedo.⁷² This incident killed forty seven South Korean sailors and sank the *ROKS Cheonan*. The sinking was a shock to the ROKN, the ROK, and the Northeast Asian region because the ROKN could not prevent the North Korean navy to attack even with more superior naval capabilities than the North Korea's navy. At the same time, North Korean navy revealed its asymmetric strategies.

In reaction to these developments, the ROKN changed the focus of its capabilities development from the blue-water navy to littoral naval warfare, submarine warfare, and Anti-Submarine warfare (ASW) capabilities to neutralize the North Korean asymmetric threats. This section discusses how the sinking of the *ROKS Cheonan* and its impact on ROK maritime strategy shaped the ROK posture with respect to maritime threats from both China and North Korea.

⁷⁰ Heginbotham, *The U.S.-China Military Scorecard*, 200; Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China 2019, Annual Report to Congress* (Washington, DC: Office of the Secretary of Defense, 2019), 14 and 35, https://media.defense.gov/2019/May/02/2002127082/-1/-1/1/2019_CHINA_MILITARY_POWER_REPORT.pdf.

⁷¹ Heginbotham, *The U.S.-China Military Scorecard*, Figure 7.9 Scorecard 5 summary coding, 199.

⁷² Kyle Mizokami, "In 2010, North Korea Sank a South Korean Warship. 40 Sailors Died Tragically," *The National Interest*, 3 March 2018. <https://nationalinterest.org/blog/the-buzz/2010-north-korea-sank-south-korean-warship-40-sailors-died-24729>.

2. The Chinese Indirect Threats and Uncertainties

The Chinese maritime threats against the ROK's submarines were indirect threats because there was no maritime conflict between the Chinese navy and the ROKN involving casualties or damage. China became an indirect threat to the ROK because China supported North Korea⁷³ and China's rise brought uncertainties to the Northeast Asian region.⁷⁴

China's response to the sinking of the *ROKS Cheonan* and shelling of Yeonpyeong Island showed that China would support North Korea even if North Korea would be at fault.⁷⁵ Compared to the United States' full support for the ROK in the sinking, China's rejection of the sinking findings done by multi-national investigation showed China's uncertainty in the North and South Korea conflicts.⁷⁶ Plus, China's complaint against a combined exercise of the ROKN and the USN, to demonstrate the close alliance to North Korea, was strong enough to change the location of the exercise from the West Sea to the East Sea.⁷⁷ This clearly showed that China was aware of what kind of military operations were happening near the Korean Peninsula, and China would oppose any events or operations that posed a possible threat to its regime.

The Chinese submarine force improvement of their operation ranges and sonar capabilities would pose a significant threat against the ROK's submarines. The U.S. Navy submarines and their ASW capabilities are considered one of the best in the world. If the Chinese submarines could pose a greater threat against the U.S. navy vessels,⁷⁸ they would pose a similar or greater threat against the ROKN. China only took eleven years to gain

⁷³ Office of the Secretary of Defense, *Military and Security Developments Involving the Democratic People's Republic of Korea: Report to Congress* (Washington, DC: Office of the Secretary of Defense, 2017), 6. <https://media.defense.gov/2018/May/22/2001920587/-1/-1/1/REPORT-TO-CONGRESS-MILITARY-AND-SECURITY-DEVELOPMENTS-INVOLVING-THE-DEMOCRATIC-PEOPLES-REPUBLIC-OF-KOREA-2017.PDF>.

⁷⁴ Terence Roehrig, "Republic of Korea Navy and China's Rise: Blancing Competing Priorities," 65.

⁷⁵ Thomas Bowditch, "Long Term Impact of the Cheonan Incident on U.S.-ROK Naval Concepts and Operations," in *U.S. and ROK Perspectives on Maritime Issues in NE Asia*, ed. Korea Institute for Maritime Strategy (Seoul: Korea Institute for Maritime Strategy, 2012), 313-336, 324-325.

⁷⁶ Bowditch, "Long Term Impact of the Cheonan Incident," 323-325.

⁷⁷ Bowditch, "Long Term Impact of the Cheonan Incident," 343.

⁷⁸ Heginbotham, *The U.S.-China Military Scorecard*, 193.

advantage over the U.S. Navy's capabilities in littoral warfare, so it would not take long for China to develop more advanced submarine and ASW capabilities. China's continued development in its maritime capabilities would expand into open seas far from its littorals because "the possession of seapower is an expression of China's growth and national power, ... China's national policies is a true expression of seapower and one that is challenging the region and beyond,"⁷⁹ according to Bowers. Additionally, China's aircraft carriers would be another future uncertainty to the ROK submarines because these carriers would have ASW aircrafts onboard.⁸⁰ Thus, the Chinese naval capabilities would continue to improve rapidly in the future, and the Chinese submarines would no longer be a restraint to the Chinese navy because ASW capability was one of the constraining elements in the Chinese navy's blue-water aspirations.⁸¹

3. The North Korean Threats

The North Korean's asymmetric capabilities using its submarines arose as the biggest threat met by the ROK's submarines. As demonstrated in the sinking of the *ROKS Cheonan* in 2010, North Korea's outdated naval equipment became lethal to the ROK when they were used with asymmetric strategies and capabilities. Despite the fact that ROK submarines' capabilities were superior to the North Korean submarines, the ROK submarines could not deter the North Korean submarines due two reasons.

First, the secretive nature of the North Korean military's and the Kim regime's objectives made it difficult for the ROKN to anticipate the North Korean navy's actions in a maritime territory. According to Bowers, "Given the secretive nature of the North Korean regime, it is impossible to completely understand the KPN's objectives under existing armistice conditions, ... Yet, it is the more offensive aspects of their operations that influence the ROKN's day-to-day strategy, tactics and deployments."⁸² Only some parts

⁷⁹ Bowers, *The Modernisation of the Republic of Korea Navy*, 14.

⁸⁰ Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China* 2019, 60.

⁸¹ Institute for Strategic Studies, *The Military Balance*, Vol 119 (London: International Institute for Strategic Studies, 2018), 236.

⁸² Bowers, *The Modernisation of the Republic of Korea Navy*, 23–24.

of the North Korean navy were influencing the ROKN's operations. Without knowing the North Korean Navy's intents or objectives, the ROK's submarine force could not defend against North Korea's overwhelming number of submarines with unknown intents and capabilities.

Additionally, the secretive nature of the North Korean military data also obscures the North Korean threats against the ROK's submarines. Unlike other countries, North Korea does not release its military information. Table 1 shows that the estimated number of North Korean submarines changes depending on the quality of the intelligence and how its submarines are categorized. Similar to its secretive objectives and opaque intents, its military information can only be analyzed through processing satellite images or through other forms of intelligence. For example, satellite images had revealed that North Korea was building a new submarine since 2010, and the images from 24 July 2014 revealed more detailed information of the new class submarine that North Korea was building.⁸³ Even U.S. intelligence assumes that North Korea is developing a new SSB based on its intelligence collected.⁸⁴ Therefore, not having a definite proof of the North Korean submarine capabilities increases the difficulty in calculating the North Korean threat level that the ROK's submarines have to face.

⁸³ Joseph S. Bermudez Jr., "The North Korean Navy Acquires a new Submarine," 38 North, last modified 19 Oct 2014, <https://www.38north.org/2014/10/jbermudez101914/>.

⁸⁴ "North Korea Submarine Capabilities," The Nuclear Threat Initiative (NTI), 4 Oct 2018, <https://www.nti.org/analysis/articles/north-korea-submarine-capabilities/>.

Table 1. North Korea’s submarines⁸⁵

	Type	YEAR 2010	YEAR 2013	YEAR 2015	YEAR 2020	YEAR 2025
Submarines, Ballistic Missile	New Construction- Sinpo-C ⁸⁶ (SSB, developing)	-	-	-	-	1
	Gorae (SSB, operational)	-	-	1	1	1
	Golf ⁸⁷ (SSG, could be developed as SSB)	-	-	1	1	1
Submarines, Attack (Deployable)	Romeo	20	20	20	20	20
	Whiskey	-	-	-	-	-
Submarines, Coastal Defense & Semi-submersibles (Deployable)	K-300 (no accurate data since 2013)	-	2+	10?	20?	20?
	Sang-O	26	28	28	28	28
	P-4	7	5	5	-	-
	Yugo	15	15	15	-	-
	U/I	+	+	+	+	+
	SILC	8+	8+	8+	8+	8+

Second, the ROK military’s miscalculation on the North Korean submarine capacity increased the damage to the ROK by North Korea’s provocations. According to Park Chang-Kwoun, “[the] South Korean navy held two miscalculations on the sub-capability of the North. The South generally thought that North Korean submarine forces could not effectively conduct operations in the West Sea due to the shallow water depth and other environmental obstacles, and the mini-sub fleet would be a launch platform for

⁸⁵ “Korean People’s Army Navy Equipment,” Global Security, last modified 19 Oct 2017, <https://www.globalsecurity.org/military/world/dprk/ship.htm>.

⁸⁶ Ankit Panda, “The Sinpo-C-Class,” *The Diplomat*, 18 October 2017, <https://thediplomat.com/2017/10/the-sinpo-c-class-a-new-north-korean-ballistic-missile-submarine-is-under-construction/>.

⁸⁷ “Sinpo / GORAE-Class Ballistic Missile Sub,” Global Security, last modified 23 Jul 2019, <https://www.globalsecurity.org/military/world/dprk/s-gorae.htm>; “Golf-class submarine could be modified to fire medium-range ballistic missiles.”

special operations rather than an attack unit to the surface vessels.”⁸⁸ Prior to the sinking of *ROKS Cheonan*, the ROKN did not anticipate that North Korean submarines would attack the ROKN’s vessels directly with torpedoes.

The North Korean military continues to create new ways to gain advantage over the ROKN by utilizing asymmetric strategies and capabilities. This includes by developing its submarine force, since its submarines were hard to detect in the vicinity of the Korean Peninsula due to environmental effect and the ROKN’s underdeveloped ASW capabilities.⁸⁹ This also includes continuing to work toward abilities to launch inter-continental ballistic missiles (ICBMs).⁹⁰ The North Korean threat level may continue to increase unless the ROKN develops the ROK submarines’ capabilities to respond against the North Korean asymmetric capabilities.

D. THE ROK SUBMARINES’ OBJECTIVE AND CAPABILITIES

The ROK military’s grand strategy, which was “to deter provocations and invasions from external forces and, if deterrence fails, achieve an early victory ‘with the least damage possible, within the shortest time possible,’”⁹¹ did not change much from the Korean War through the end of the Cold War. However, as threats and uncertainties surrounding the Korean Peninsula changed, the ROKN attempted to become a blue-water navy by developing more open sea capabilities than littoral maritime capabilities after 1995.⁹² The ROKN had begun developing its submarine capabilities as part of its naval modernization in the 1990s to hedge against increasing anti-access capabilities in the East Asian maritime

⁸⁸ Chang-Kwoun Park, “The Long Term Impacts of Cheonan Sinking on the Alliance Naval Concepts and Operations,” in *U.S. and ROK perspectives on Maritime issues in NE Asia*, ed. Korea Institute for Maritime Strategy (Seoul: Korea Institute for Maritime Strategy, 2012), 337-365, 341.

⁸⁹ Republic of Korea Ministry of National Defense, *The ROK Defense White Paper 2018* (Seoul: Republic of Korea Ministry of National Defense, 2018), 30.

⁹⁰ Anthony H. Cordesman, *The Military Balance in the Koreas and Northeast Asia: Final Review Edition* (Washington, DC: Center for Strategic and International Studies, 2016), Fig VI.1, 310. <https://www.csis.org/analysis/final-review-military-balance-koreas-and-northeast-asia>.

⁹¹ The ROK Ministry of Defense, *ROK Defense White Paper 2018*, 46.

⁹² Bowers, *The Modernisation of the Republic of Korea Navy*, 1.

region.⁹³ Even though the ROKN's direct threat was the North Korean military, the ROK military was not focused on defeating the North Korean threats because the ROKN's and the North Korean navy's capabilities gap widened as the ROK used its economic growth to develop its maritime capabilities while North Korea's economy stagnated.⁹⁴

Despite the ROKN's effort to improve its capabilities in accordance with the ROK's national interests, obstacles against the ROK's submarine force development accumulated. The ROKN's overall submarine force capabilities increased, but the ROK submarines' advancement was not focused on North Korea's asymmetric capabilities or ASW. The ROK submarines' advanced capabilities were due to developing the entire ROK military and protecting the ROK's maritime trade by becoming a blue-water navy.⁹⁵ Prior to the *Cheonan* sinking, the ROKN put more emphasis on its regional maritime interests and sea lines of communication (SLOC) to protect the ROK's trade routes that were important to the ROK's economy.⁹⁶ The goal of maritime trade routes' protection stemmed from the ROK's national interests and strategic objectives that corresponded to becoming an independent, responsible middle power in the region.⁹⁷ Prior to the sinking of the *ROKS Cheonan*, the ROK submarines focused on the visible uncertainty, China's rise, and the conventional North Korean threats. Thus, the North Korean conventional capabilities and China's rise became the threats for the ROK military to overcome.

The sinking of the *ROKS Cheonan* in 2010 changed the ROKN's objectives and capabilities' development. The sinking of the *ROKS Cheonan* redefined the ROK's maritime security environment. Prior to the sinking, the ROKN focused on its overall seapower growth without prioritizing in any specific warfare. After the sinking, the role of submarines and ASW capabilities became more important in achieving the ROKN's objectives because submarines were one of the few assets that could achieve the ROKN's

⁹³ Bowers, *The Modernisation of the Republic of Korea Navy*, 6–7.

⁹⁴ Bowers, *The Modernisation of the Republic of Korea Navy*, 29.

⁹⁵ Chun In-Bum, "Korean Defense Reform: History and Challenges", *Brookings Institution*, Oct 31 2017, <https://www.brookings.edu/research/korean-defense-reform-history-and-challenges/>.

⁹⁶ Bowers, *The Modernisation of the Republic of Korea Navy*, 6.

⁹⁷ Bowers, *The Modernisation of the Republic of Korea Navy*, 6.

objectives by meeting the North Korean threats in the littoral warfare.⁹⁸ Thus, the sinking narrowed the ROKN's development focus toward ASW and submarine warfare. According to Bruce Klingner, "Following the Cheonan attack, Chief of Naval Operations Admiral Kim Sung-chan redirected the navy's focus away from a decade-long emphasis on blue-water operations toward increased readiness against North Korean attacks."⁹⁹ ROK submarines lacked the range and numbers to cover the entire Korean Peninsula maritime area. Thus, the ROKN in 2011 initiated a plan to acquire nine KSS-III diesel-powered submarines to cover the entire Korean Peninsula.¹⁰⁰

The ROK submarines' capacities will not only increase to carry out the ROKN's littoral warfare objectives from 2022, but they will also generate a capacity for the ROK submarine force to patrol outside the Korean Peninsula maritime area. As Table 2 lists, by 2029 the ROKN will have more submarines that can better deny the North Korean submarines with longer underwater operation time.¹⁰¹ If the ROK submarine force reaches the full capacity, the ROK submarines will have better sonar equipment to detect the North Korean midget and mini submarines in littoral water because KSS-III submarines will be in service. Plus, since 2014 the USN and the ROKN have formed the ASW Cooperation Committee to improve the ROKN's submarine warfare and ASW capabilities.¹⁰² By the time the ROK submarines' modernization is complete, they can gain intelligence on the North Korean vessels, detect and deter the North Korean submarines, and lay mines in the Korean Peninsula maritime environment.¹⁰³

⁹⁸ Bowers, *The Modernisation of the Republic of Korea Navy*, 73.

⁹⁹ Bruce Klingner, "Measures to Enhance Combined South Korean-US Naval Capabilities," *The Journal of East Asian Affairs* 27, no. 1 (Spring 2013): 1–22, 6.

¹⁰⁰ "KSS-III SSX Jangbogo-III Class," Global Security, last modified 12 Oct 2019, <https://www.globalsecurity.org/military/world/rok/kss-3.htm>.

¹⁰¹ Bowers, *The Modernisation of the Republic of Korea Navy*, 94–95.

¹⁰² Abraham Essenmacher, "US, ROK Navies Strengthen Partnerships through ASW cooperation," *Commander United States Pacific Fleet*, 27 Apr 2015, <https://www.cpf.navy.mil/news.aspx/030536>.

¹⁰³ Anthony H. Cordesman, Fig VI.11, 29.; Bruce Klingner, "Enhancing South Korean-U.S. Naval Capabilities is Critical to American Interests," *Backgrounders*, No.2829 (Washington, DC:The Heritage Foundation, July 2013), 8–9, http://thf_media.s3.amazonaws.com/2013/pdf/bg2829.pdf.

The ROK submarines' future objectives will likely focus both on the immediate threats from North Korea and broader regional and global threats. The North Korean threats pose near term threats, but these threats will reach their limits because the North Korean military does not and will not have enough funding to out-develop the ROKN's capabilities. However, North Korea's secretive military capabilities and developments still threaten the ROK. Plus, the ROK's more peaceful security policies in the Korean Peninsula do not decrease frequencies or levels of the North Korean threats. For example, during Kim Dae-Jung's presidency, he engaged North Korea through political, economical, and cultural cooperation instead of force through his sunshine policy on North Korea.¹⁰⁴ However, North Korea's aggressiveness toward the ROK did not change because North Korea began attacking overtly after 1999 using its maritime capabilities.¹⁰⁵

Despite the ROK's more peaceful security policies toward North Korea due to change of the leadership from a conservative party to a progressive party in 2017, the ROK continues to develop its security capabilities in both littoral warfare and blue-water navy objectives. According to the 2018 ROK Defense White Paper, "[r]egarding the policy goal for security, 'a peaceful and prosperous Korean Peninsula,' the administration established three national security objectives: a peaceful resolution of the North Korean nuclear issue and the establishment of permanent peace; contribution to peace and prosperity in Northeast Asia and the world; and the realization of a society where people's safety and lives are protected."¹⁰⁶ It may seem as if the ROK is focusing less on the littoral threats from North Korea, but the ROK is looking to increase the ROKN's capacity to handle both the littoral warfare and blue-water navy objectives. With the ROKN's KSS classes submarines, the littoral warfare will be covered. As to the blue-water navy objectives, the

¹⁰⁴ David Straub, "Salvaging the Sunshine Policy, Joint U.S.-Korea Academic Studies," Korea Economic Institute of America (Washington, DC: Korea Economic Institute of America, 2017), 18. http://www.keia.org/sites/default/files/publications/jukas_1.1_salvaging_the_sunshine_policy.pdf.

¹⁰⁵ Nicholas Macfie, "Factbox: The battles of the Korean West Sea," *Reuters*, 29 Nov 2010, <https://www.reuters.com/article/us-korea-north-clashes/factbox-the-battles-of-the-korean-west-sea-idUSTRE6AS1AL20101129>.

¹⁰⁶ The ROK Ministry of Defense, *ROK Defense White Paper 2018*, 39; "South Korean Military Doctrine," Global Security, last modified 16 Jan 2019, <https://www.globalsecurity.org/military/world/rok/doctrine.htm>.

ROK has begun to examine ways to achieve these objectives. President Moon has expressed his interest in acquiring nuclear-powered submarines,¹⁰⁷ and the ROK formed a task force team to evaluate possibility and feasibility of nuclear-powered submarines acquisition.¹⁰⁸

Table 2. The ROKN’s current submarine force¹⁰⁹

Class	Manufacturer	Role	Original total	In service	Commissioned
KSS-II (Type 214)	Hyundai	Attack	9	7	2007
Chang Bogo (Type 209)	HDW/Daewoo	Attack	9	9	1993
Dolphin (Cosmos)	n/a	Midget	6	6	n/a
KSS-III Batch 1	DSME	Attack	3 (by 2022)	1	2018
KSS-III Batch 2	DSME	Attack	3 (by N/A)	0	n/a
KSS-III Batch 3	DSME	Attack	3 (by 2029)	0	n/a

E. CONCLUSION

The ROK’s submarines enhance the ROKN’s ability to achieve its objectives—deny threats in the ROK’s maritime territory and deter threats to its maritime trade routes—because their capabilities are developed to deter the North Korean maritime threats. The Northeast Asian security environment has changed since the 1990s due to the Soviet Union’s collapse and China’s rise. However, the ROK only focused its naval capabilities’ development on blue-water navy because China’s rise was apparent and the North Korean

¹⁰⁷ Ji-Hye Jun, “South Korea moving to build nuclear-powered submarines,” *The Korea Times*, 5 Sep 2017, https://www.koreatimes.co.kr/www/nation/2018/10/205_235969.html.

¹⁰⁸ Agence France-Presse, “South Korean navy considering acquiring nuclear submarines,” *The Straits Times*, 11 Oct 2019, <https://www.straitstimes.com/asia/east-asia/s-korean-navy-considering-acquiring-nuclear-submarines>.

¹⁰⁹ Adapted from Institute for Strategic Studies, *The Military Balance*, 285; “DSME Launched ROK Navy’s 1st 3000 tons KSS-III Submarine Dosan Ahn Chang-ho,” Navy Recognition, last modified 17 Sep 2018, <https://www.navyrecognition.com/index.php/news/defence-news/2018/september-2018-navy-naval-defense-news/6491-dsme-launched-rok-navy-s-1st-3000-tons-kss-iii-submarine-dosan-ahn-chang-ho.html>.

maritime threats appeared non-threatening due to the inferiority of the North Korean navy's capabilities.

The sinking of the *ROKS Cheonan* in 2010 by North Korea transformed the Northeast Asian security environment by introducing its asymmetric military capabilities, and the sinking revealed the ROKN's weakness in ASW and submarine warfare. Even though the ROKN is superior in terms of equipment, it is not perfect in every form of warfare. Plus, the secretive nature of the North Korean military also makes difficult for the ROKN to assess the North Korean military's objectives.

Despite the Chinese naval development, the ROK military is not concerned with the Chinese submarines' uncertainties in the region. The ROK's 2018 Defense White paper emphasized China's "improving long-range power projection capabilities" by its aircraft carriers¹¹⁰ and how the Chinese military aircraft began to enter the Korea Air Defense Identification Zone (KADIZ) without permission. However, there is no mention of the Chinese submarines posing concerns in the region. In the ROK's perspective, China poses the regional power projection concern to the ROK while the biggest concern against its submarines comes from the North Korean submarines.

The *Cheonan* sinking altered ROK perspectives on maritime security. In the short-run, the ROK shifted from blue-water naval development to littoral warfare capabilities. Over time, the ROK has now come to pursue both the littoral naval warfare and blue-water navy objectives, due to the secretive and erratic nature of North Korean threats and the growing regional and global uncertainties. Increasing the ROK's submarine force enhances the ROKN's ability to achieve these objectives, but if the ROK does not continually assess the North Korean objectives and the regional maritime security environment, the ROKN's capabilities to achieve its objectives will degrade even with its naval superiority over the North Korean navy. ROK interest in acquiring nuclear-powered submarines arises from its desire to keep up with the evolving regional threat environment while pursuing both blue-water and littoral maritime objectives.

¹¹⁰ The ROK Ministry of Defense, *ROK Defense White Paper 2018*, 17.

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III. TECHNICAL EVALUATION

Technical evaluation of various Anti-Submarine Warfare (ASW) assets' costs and capabilities will reveal advantages and disadvantages in accordance with the ROKN's objectives, which are littoral warfare and blue-water navy. This chapter compares the relative costs and capabilities to evaluate which ASW assets will achieve the ROKN's littoral warfare objective and blue-water objective, respectively, and which assets will provide most flexibility given uncertainty about the relative priority of the littoral warfare and bluewater objectives.

Submarine capabilities can be measured by their contribution to undersea warfare. Submarines are the most essential assets in undersea warfare, but undersea warfare includes antisubmarine warfare (ASW) and mine warfare (MIW).¹¹¹ According to Joint Publication 3-32: "Undersea warfare (USW) operations are conducted to establish dominance in the undersea portion of the maritime operational area, which ... denies an opposing force the effective use of underwater systems and weapons. USW includes offensive and defensive submarine, ASW, and mine warfare (MIW) operations."¹¹² Therefore, this technical evaluation targets various ASW platforms. However, MIW assets are not included because the use of MIW to reduce submarine threats during peacetime is not feasible. MIW is mostly performed by actively laying mines on water to reduce submarine threats during wartime under a joint task force.¹¹³ Therefore, MIW is likely to constrain the rules of engagement before the enemy's hostility is confirmed.¹¹⁴

The other aspect of technical evaluation is the cost of each ASW asset. An accurate cost analysis of acquiring nuclear-powered submarines and a comparison of various ASW

¹¹¹ James R. Fitzgerald, "More than Submarine vs. Submarine," *Proceedings* 139, no. 2 (Feb 2013), 32-37, 33.

¹¹² Joint Chiefs of Staff, *Command and Control for Joint Maritime Operations*, JP 3-32 (Washington, DC: CJCS, 8 June 2018), IV-10, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_32.pdf?ver=2018-07-23-161257-897.

¹¹³ Joint Chiefs of Staff, *Command and Control for Joint Maritime Operations*, IV-14—IV 16.

¹¹⁴ Ralph G. Stokes and Richard Thompson, "Naval Service Roles and Missions in Littoral Warfare," *Johns Hopkins APL Technical Digest* 14, no. 2 (Nov 1993), 102-111, 107.

assets' cost is an important element in the technical evaluation. When a country plans a major military equipment purchase, which may cost billions of dollars, a careful cost and performance analysis is required; otherwise the project will have a higher chance of running into obstacles, and the purchase may not be worth much to the country. Hon. John F. Tierney said in a congressional hearing, "Waste is waste, regardless of the context, and inefficiencies only hurt our ability to respond effectively to crises and promote our national security interests. Sound national security in an austere budget environment requires strategic choices and rational resource allocation. Bigger is not always better, especially in matters of national defense."¹¹⁵

Acquiring the most advanced equipment can waste money and effort if a country does not perform a life cycle cost analysis. For example, the United States Navy (USN) decided to build a *SEAWOLF* class nuclear-powered submarine, which was the most expensive in the USN and the most capable U.S. nuclear-powered submarine ever made to hunt Russian submarines. But the USN did not run a thorough cost analysis for its full life cycle because the United States was in a hurry due to the arms race with the Soviet Union.¹¹⁶ Thus, even though the original plan was to build 29 *SEAWOLF* submarines, only three were built due to the increased cost of building and operating these submarines.¹¹⁷ The *SEAWOLF* class submarines project did not improve the USN's submarine capability even though it was the most expensive and advanced U.S. submarine project. Therefore, a careful cost-reality analysis before committing itself to acquiring nuclear-powered submarines would help the Republic of Korea (ROK) military not to repeat the same mistake that the USN made.

This chapter evaluates the relative costs of nuclear-powered and conventional submarines, the capabilities and performance of different ASW platforms, and broader

¹¹⁵ Committee on Oversight and Government Reform, 111th Congressional Hearings, House of Representatives (July 2010), <https://www.govinfo.gov/app/details/CHRG-111hrg65555/CHRG-111hrg65555>.

¹¹⁶ John F. Schank, Cesse Ip, Frank W. Lacroix, Robert E. Murphy, Mark V. Arena, Kristy N. Kamarck, and Gordon T. Lee, *Learning From Experience, Vol.II, Lessons from the U.S. Navy's Ohio, Seawolf, and Virginia Submarine Programs* (Santa Monica, CA: RAND Corporation, 2011), 43.

¹¹⁷ Schank et al., *Learning From Experience*, 48.

considerations affecting the cost of nuclear-powered submarine acquisition. In so doing, this chapter provides a more comprehensive assessment of the cost-benefit element of nuclear-powered submarine acquisition than currently exists, specified in terms of the ROKN's abilities to accomplish divergent national security objectives.

A. COST

1. Estimated Cost of ROK Acquiring Nuclear-Powered Submarines

There are two options for the ROK to acquire nuclear-powered submarines. One is to manufacture them on its own, and the other is to purchase them from another country. However, manufacturing nuclear-powered submarines is not likely because no country would sell its nuclear-powered vessel building technologies and it would take a decade or more to develop and manufacture a nuclear-powered submarine from scratch. Consequently, in this thesis, purchasing as an option for the ROK's acquisition of nuclear-powered submarines will be the only consideration.

Similar to many variations in diesel-electric submarines, there are several kinds of nuclear-powered submarines. However, the *Barracuda* class submarine, which France manufactures, is a likely model for the submarine the ROKN may purchase. The ROKN is unlikely to purchase a U.S. submarine because the United States will not sell and has not sold its nuclear-powered vessels to any country, and the U.S. submarines run on highly enriched uranium (HEU), which the ROK will not be able to utilize due to the 123 Agreement with the United States.¹¹⁸ In order for the ROKN to purchase nuclear-powered submarines, it will need at least \$7 billion to acquire three *Barracuda* class nuclear-powered submarines,¹¹⁹ plus \$2.1 billion for a submarine base with the maintenance infrastructure to support and maintain these nuclear-powered submarines.¹²⁰ On top of these costs, the ROKN will need to train 60 sailors per nuclear-powered submarine, costing

¹¹⁸ Spencer R. Weart, *The Rise of Nuclear Fear* (Cambridge: Harvard University Press, 2012), 91.

¹¹⁹ Keck and Sokolski, "South Korea is about to Make a \$7 Billion Nuclear Submarine Blunder"; Hugh Chalmers and Malcolm Chalmers, *Relocation, Relocation, Relocation: Could the UK's nuclear Force be moved after Scottish independence?* (London: Royal United Services Institute, 2014).

¹²⁰ Keck and Sokolski, "South Korea is about to Make a \$7 Billion Nuclear Submarine Blunder."

approximately \$1 million.¹²¹ Thus, the initial cost for the ROKN to obtain a plausible nuclear-powered submarine capability with three *Barracuda* submarines with a maintenance facility to maintain these submarines is at least \$9.1 billion.

Additionally, there are recurring expenses in operating nuclear-powered submarines. Nuclear-powered submarines usually have a 7–10 year of operational period, depending on how the ROKN operates them, before refueling during an overhaul,¹²² and a refueling process is estimated to cost \$90 million per one reactor.¹²³ The life cycle of a nuclear submarine is approximately 33 years,¹²⁴ and a nuclear-powered submarine's annual operating cost is approximately \$140 million.¹²⁵ Taking operational and refueling costs together, a nuclear-powered submarine would require \$5 billion during its 33 years of operation.¹²⁶ Lastly, scrapping a nuclear reactor from a nuclear-powered submarine costs approximately \$140 million due to the processing of nuclear waste from a vessel's nuclear reactor.¹²⁷ All these costs are summarized in Table 3.

¹²¹ Charles Meade, Robert J. Lempert, Fred Timson, and James Kadtko, *Assessing the Benefits and Costs of a Science Submarine* (Washington, DC: RAND Corporation, 2001), 55-56, https://www.rand.org/pubs/monograph_reports/MR1369z0.html#toc; However, this data is based on 98 member crew with annual salary and allowances. Hence, if the training and certification for the ROKN crew is done annually, the cost of ROKN sailors will be significantly reduced. Therefore, this thesis assumes that it will cost 25% of what it would have cost the USN.

¹²² “Nuclear-powered ships,” World Nuclear Association, last modified October 2019, <http://www.world-nuclear.org/information-library/non-power-nuclear-applications/transport/nuclear-powered-ships.aspx>.

¹²³ Meade et al., *Assessing the Benefits and Costs of a Science Submarine*, 53.

¹²⁴ John F. Schank, Mark V. Arena, Paul DeLuca, Jessie Riposo, Kimberly Curry, Todd Weeks, James Chiesa, *Sustaining U.S. Nuclear Submarine Design Capabilities* (Santa Monica, CA: RAND Corporation, 2007), 2, <https://www.rand.org/pubs/monographs/MG608.html>.

¹²⁵ Marcus Hellyer, “Going nuclear: would US submarines be a cheaper option? *The Strategist*, 24 Sep 2018, <https://www.aspistrategist.org.au/going-nuclear-would-us-submarines-be-a-cheaper-option/>.

¹²⁶ Hellyer, “Going nuclear: would US submarines be a cheaper option?”

¹²⁷ Congressional Budget Office, *The Cost-Effectiveness of Nuclear Power for Navy Surface Ships* (Washington, DC: Congressional Budget Office, 2011), 8, <https://www.cbo.gov/sites/default/files/112th-congress-2011-2012/reports/05-12-nuclearpropulsion.pdf>.

Table 3. Cost of a nuclear-powered submarine during its 33-year life cycle

Category of Cost	Price (\$) / unit	# units	Total Price
One <i>Barracuda</i> class submarine	\$ 2,330 million	1	\$ 2,330 million
Nuclear reactor refuel	\$ 90 million	4	\$ 360 million
Operation cost per year	\$ 140 million	33	\$ 4,620 million
Crew training (every 3 years)	\$ 1 million*	11	\$ 11 million
Nuclear reactor dismantling	\$ 140 million	1	\$ 140 million
Total cost/submarine			\$ 7,461 million

* Crew training is three times more than a diesel-powered submarine to train and maintain nuclear engineering technologies to the crew.

2. The ROK Diesel-Electric Submarine Cost

In order to assess approximately how much the ROKN would spend on acquiring equivalent diesel-electric submarines, this section identifies their costs, summarized in Table 4.

The ROKN's newest submarine being manufactured is KSS-III, which is labeled as *Dosan An Chang-Ho*. This 3000-ton class submarine's price is 2.5 trillion won (\$900 million).¹²⁸ This submarine requires 50 sailors to operate, and is the first ROKN submarine with a Vertical Launching System (VLS) which can carry 10 cruise missiles.¹²⁹ Due to the VLS function, it may be able to develop the capability to use a Submarine Launched Ballistic Missile (SLBM) according to the Korea Ministry of Defense (MND).¹³⁰

The other diesel-electric classes of submarines the ROKN has are Type-214 and Type-209. The Type-214 (KSS-II) submarine, which is an 1800-ton diesel-electric submarine, is approximately \$373 million each,¹³¹ and requires 30 sailors to operate.¹³² However, as technology continues to advance, the ROKN has installed more advanced

¹²⁸ Global Security, "KSS-III Jangbogo-III Class."

¹²⁹ "DSME lands ROK Navy KSS-III submarine design, construction Contract," *Naval Today*, 11 Oct 2019, <https://navaltoday.com/2019/10/11/dsme-lands-rok-navy-kss-iii-submarine-design-construction-contract/>.

¹³⁰ Sebastien Roblin, "Are South Korean Submarines About to Go Nuclear?" *The National Interest*, 9 Mar 2019, <https://nationalinterest.org/blog/buzz/are-south-korean-submarines-about-go-nuclear-46582>.

¹³¹ "Type 214/Type 209PN," Global Security, last modified 15 Aug 2017, <https://www.globalsecurity.org/military/world/europe/type-214.htm>.

¹³² Global Security, "Type 214/Type 209PN."

equipment in the Type-214 submarines, which have become the ROKN’s workhorse. Therefore, the last six Type-214 submarines’ cost increased to \$583 million each.¹³³ The other class is the Type-209 (KSS-I) submarine, which is a 1300-ton diesel-electric submarine. Its original price was approximately \$293 million each,¹³⁴ but similar to the Type-214 submarine, the Type-209 submarine price is now \$356 million each due to advanced equipment installation.¹³⁵

Table 4. ROKN submarines’ cost status as of 2018¹³⁶

Class	Ton	# of crew	Price when introduced (\$)/one	Price now (\$)/one	# in ROKN service
Type-209 (KSS-I)	1300	30	293 million	356 million	7
Type-214 (KSS-II)	1800	30	373 million	583 million	9
KSS-III	3000	50	900 million	900 million	0 (9*)

*Operational by 2029.

The ROKN’s diesel-powered submarine force will evolve around KSS-III as it has begun to acquire KSS-III submarines to replace Type-209 submarines. Since this thesis compares the ROKN’s possible submarines in the future, a total cost comparison during a 33 year life cycle of a submarine is the most appropriate. Table 5 shows how much a KSS-III would cost if it were to operate for 33 years (equivalent to a nuclear-powered submarine lifetime). This table assumes that marine diesel fuel is \$3.00 per gallon, operation cost per year is same as a nuclear-powered submarine, and crew training and operation cost per year cost less a than nuclear-powered submarine due to no nuclear technologies training. Thus, the total cost to field a KSS-III submarine for 33 years is \$3,124.2 million.

¹³³ Institute for Strategic Studies, *The Military Balance*, Table 14, 318.

¹³⁴ Franz-Stefan Gady, “Indonesia Commissions First Attack Submarine in 34 years,” *The Diplomat*, 3 Aug 2017, <https://thediplomat.com/2017/08/indonesia-commissions-first-attack-submarine-in-34-years/>.

¹³⁵ Novan Iman Santosa, “RI orders 3 submarines worth \$1b in regional ‘catch-up’,” *The Jakarta Post*, 22 December 2011, <https://www.thejakartapost.com/news/2011/12/22/ri-orders-3-submarines-worth-1b-regional-catch.html>.

¹³⁶ Summary of data from the previous paragraph in table format.

Table 5. Cost of likely diesel-powered submarine during a 33-year life cycle

Category of cost	Price (\$) / unit	# units	Total Price
One KSS-III submarine	\$ 900 million	1	\$ 900 million
Fuel costs (per year)	\$ 1.43 million ¹³⁷	33	\$ 47.2 million
Operation cost per year	\$ 93 million ¹³⁸	33	\$ 3,069 million
Crew training (every 3 years)	\$ 0.5 million	11	\$ 5.5 million
Dismantling	\$ 2.5 million ¹³⁹	1	\$ 2.5 million
Total cost/submarine			\$ 4,024.2 million

Some proponents argue that nuclear-powered submarines are more cost efficient than diesel-electric submarines due to oil price fluctuations and a longer period of deployment. According to the U.S. Congressional Budget Office (CBO), nuclear vessels would be more expensive than conventional vessels if average oil prices at \$86/barrel in 2011, increased at a 1% inflation rate for 40 years.¹⁴⁰ Therefore, if average oil prices were lower than the U.S. CBO’s calculation, a diesel-electric submarine is the better option from a cost perspective. Additionally, the ROKN’s diesel-powered submarines’ fuel efficiency will increase due to the ROKN’s acquisition of KSS-III submarines that have better fuel and battery efficiencies by 2029.¹⁴¹ While it is true that nuclear-powered submarines do not require additional funding in fuel once constructed with reactors for seven to ten years, some studies estimate that the price of oil is not likely to increase above \$114/barrel by

¹³⁷ Calculation of diesel fuel consumed: 52weeks*(4wk/5wk)*11424gal/wk = 475,238 gallons of Diesel needed/year. See “Approximate Diesel Fuel Consumption Chart,” Diesel Service & Supply, accessed last on 7 Dec 2019, https://www.dieselserviceandsupply.com/Diesel_Fuel_Consumption.aspx; Konstantinos Psallidas, Clifford A. Whitcomb, and John C. Hottman, “Design of Conventional Submarines with Advanced Air Independent Propulsion Systems and Determination of Corresponding Theater-Level Impacts,” *Naval Engineers Journal* 122, no. 1 (2010), 111-123, DOI: 10.1111/j.1559-3584.2010.00196.x; Thomasz Lus, “Waiting for Breakthrough in Conventional Submarine’s Prime Movers,” *Transactions on Maritime Science* 4, no. 1 (2019), 37-45, doi: 10.7225/toms.v08.n01.004. \$3/gal*475,238 gal = \$1.425 million. See “Fuel Price Reports”, Waterway Guide, accessed on 7 Dec 2019, <https://www.waterwayguide.com/fuel-price-report/10>.

¹³⁸ Hellyer, “Going nuclear: would US submarines be a cheaper option?”

¹³⁹ A.E. Mansour, P.T. Pederson, and J.K. Paik, Wave energy extraction using decommissioned ships,” *Ships and Offshore Structures* 8, no. 5 (2013), 504-516, <https://doi.org/10.1080/17445302.2012.723874>.

¹⁴⁰ Congressional Budget Office, The Cost-Effectiveness of Nuclear Power for Navy Surface Ships, 1-2.

¹⁴¹ Roblin, “Are South Korean Submarines About to Go Nuclear?”

2040.¹⁴² In contrast, oil prices have fluctuated more than ten percent annually in the last five years,¹⁴³ while nuclear fuel prices have slowly decreased in the last five years.¹⁴⁴ Nuclear fuel’s price stability would allow the ROK to allocate accurate funding for the nuclear-powered acquisition, but the expensive price tag of nuclear related materials and maintenance outweighs the price stability.

3. Comparison of Costs for Nuclear-Powered Submarines and Diesel-Powered Submarines

The preceding sections provided the unit lifetime costs for nuclear-powered and diesel-powered submarine options. As noted above, if the ROKN were to purchase nuclear-powered submarines, it would also need to spend \$2.1 billion for a submarine base with the maintenance infrastructure to support and maintain these nuclear-powered submarines. Hence, the total cost for a force of three nuclear-powered submarines over a 33-year lifespan can be estimated at \$24.5 billion. Given the unit cost to purchase and sustain KSS-III class diesel-powered submarines over the same 33-year period (\$4.03 billion), the ROKN for approximately the same total cost would be able to obtain six diesel-powered submarines. Table 6 provides a side-by-side comparison of the acquisition opportunities of a nominal \$24.5 billion provision:

Table 6. Submarine options cost comparison for 33-year life cycle

Category of cost	Price (\$) / unit	# units	Total Price
One <i>Barracuda</i> class submarine, lifetime	\$7.46 billion	3	\$22.4 billion
Nuclear-powered Submarine Base	\$2.10 billion	1	\$2.1 billion
Total, nuclear-powered submarine force			\$24.5 billion
One <i>KSS-III</i> submarine submarine, lifetime	\$4.03 billion	6	\$24.3 billion
Total, diesel-powered submarine force			\$24.3 billion

¹⁴² Congressional Budget Office, The Cost-Effectiveness of Nuclear Power for Navy Surface Ships, 1-2.

¹⁴³ “Short-Term Energy Outlook; Real Prices Viewer,” Energy Information Administration, accessed on 13 Nov 2019, <https://www.eia.gov/outlooks/steo/realprices/>.

¹⁴⁴ “Uranium Marketing Annual Report,” Energy Information Administration, accessed on 14 Nov 2019, <https://www.eia.gov/uranium/marketing/table1.php>.

Thus, the ROK military would be able to acquire twice as many submarines for the same amount of money, or it would cut the cost by one-half if the ROKN acquired same number of diesel-electric submarines as nuclear-powered ones.

B. ASW CAPABILITIES COMPARISON

Measurement of ASW performance is the most accurate means for various assets' effectiveness against submarine threats. ASW performance is an important factor for the ROK's acquisition of nuclear-powered submarines because, if the objective is littoral warfare, the main purpose for the acquisition would be to improve ASW capabilities against the North Korean asymmetric threats by submarines. At the same time, ASW performance is also an important factor if the objective is bluewater capability, because the purpose would be to improve ASW capabilities broadly, including but not limited to North Korean submarine threats.

Evaluation of ASW assets to determine which asset has the best ASW capability depends on the environment, duration of missions, offensive or defensive nature of the mission, etc. However, this ASW performance evaluation does not mean that the best performing ASW asset is the best choice for the ROKN to achieve its objectives because the ROKN may not need to have the best performing ASW asset to accomplish ASW missions against the North Korean submarines. The ROK would not want to bring a sword to a gunfight, but it should not bring a nuclear missile to a gunfight, either. According to the Littoral Anti-submarine Warfare Concept, "The best ASW system is one that can detect, target and neutralize well outside of the adversary submarine's sphere of influence on our forces afloat or ashore."¹⁴⁵ Thus, determination of the best ASW asset would depend on the type of ASW missions that the ROKN would pursue, whether that was a littoral naval operation or hunting a submarine in open water.

¹⁴⁵ Naval Doctrine Command, *Littoral Anti-submarine Warfare Concept* (Washington, DC: Federation of American Scientists, 1998), <https://fas.org/man/dod-101/sys/ship/docs/aswcncpt.htm>.

1. Nuclear-Powered and Diesel-Powered Submarine Capabilities

The differences between diesel-powered and nuclear-powered submarines are the energy sources that power these submarines. Diesel-powered submarines use fossil fuel and diesel, and nuclear-powered submarines use enriched uranium to generate electricity and propulsion. This difference affects submarines' speeds, ranges, mission sets, and missions' duration.

Diesel-powered submarines have limited speeds, ranges, and types of equipment onboard because these submarines can only carry a certain amount of diesel onboard. Therefore, these submarines have shorter ranges, shallower maximum depth, and fewer types of equipment than nuclear-powered submarines because the finite amount of diesel can only generate limited power. For example, the Type 214 class submarine, ROK's best submarine in operation, has a dive depth of 400 meters, four torpedo tubes, and uninterrupted underwater time of two weeks (240kw).¹⁴⁶

Despite the limited features of diesel submarines, diesel submarines are better than nuclear-powered submarines with regards to quietness and littoral operations. With the limited underwater time of two weeks, diesel-powered submarines are quieter than nuclear-powered submarines because these submarines do not have sophisticated machinery that is noisy when in operation.¹⁴⁷ Additionally, diesel-powered submarines are shorter and narrower than nuclear-powered submarines, so they can better operate in shallower water than nuclear-powered submarines.¹⁴⁸ Thus, they can execute littoral operations with less risk of grounding while nuclear-powered submarines risk running aground when they operate in shallow water due to their large sizes.

On the other hand, a nuclear-powered submarine's energy source duration is measured in years not weeks. A nuclear-powered submarine refuels every 7–10 years

¹⁴⁶ "U212/U214 Submarines," Naval Technology, last accessed on 12 Nov 2019, https://www.naval-technology.com/projects/type_212/.

¹⁴⁷ William S Murray, "An Overview of the PLAN submarine force," in *China's future nuclear submarine force*, ed. Lyle Goldstein (Annapolis: Naval Institute Press, 2012), 59-76, 65.

¹⁴⁸ Murray, "An Overview of the PLAN submarine force," 65.

depending on its fuel usage due to the long half-life of uranium.¹⁴⁹ Therefore, a nuclear-powered submarine's energy is unlimited compared to diesel-powered submarines. While a Type 214 class submarine can have 240 KW for two weeks of underwater time, a *Barracuda* class submarine built in 2017 can have 50 MW of thermal power with 10 MW of propulsion power at any time for 7–10 years.¹⁵⁰ However, a *Barracuda* class is limited to 70 days of underwater time due to limited food supplies for a 60-person crew.¹⁵¹ A nuclear-powered submarine can have deeper dive depth, longer operational range, any equipment onboard, and unlimited underwater time. Therefore, these features allow nuclear-powered submarines to have a tactical flexibility, so once these submarines are detected, they can run and hide for a long time while diesel-powered submarines have limited time to run and hide.¹⁵²

2. Surface Vessel

Unlike submarines, surface vessels are noisy due to the wakes they generate as they sail through the water. Submarines' quietness in their stealth capability is no concern for surface vessels, so surface ships do not hesitate to use active sonar systems to detect a possible submarine underwater. The most known surface vessel's ASW combat system is the United States' AN/SQQ-89(V) system, which integrates several systems to detect submarines.¹⁵³ This system uses bow and hull mounted arrays to relay the sonar data to

¹⁴⁹ World Nuclear Association, "Nuclear-Powered Ships,"; A French small nuclear-powered submarine, *Rubis*-class with 7% enriched fuel, the *Barracuda* submarines refuels in 10 years with 5% enriched fuel.

¹⁵⁰ World Nuclear Association, "Nuclear-Powered Ships"; Military Factory, "Barracuda/Suffren (class)," last modified Jan 2019, https://www.militaryfactory.com/ships/detail.asp?ship_id=barracuda-suffren-nuclear-attack-submarine-class-french-navy; J.M.K.C. Donev, Jason, Jordan Hanania, and James Jenden (2018), Energy Education - Megawatts thermal [Online]. Available: https://energyeducation.ca/encyclopedia/Megawatts_thermal. [Accessed: November 17, 2019]; Since K-15 reactor's efficiency is approximately 20% in converting thermal energy to propulsion energy, K-15 on *Barracuda* class submarine's propulsion energy is approximately 10 MW (50 MWt x 20% efficiency = 10 MW propulsion).

¹⁵¹ David Szondy, "France launches its first Barracuda class nuclear attack submarine," *New Atlas*, 17 Jul 2019, <https://newatlas.com/france-nuclear-attack-submarine-launch/60593/>.

¹⁵² Murray, "An Overview of the PLAN submarine force," 66.

¹⁵³ "AN/SQQ-89(V) UNDERSEA WARFARE/ANTI-SUBMARINE WARFARE COMBAT SYSTEM," United States Navy Fact File, The U.S. Navy, last modified 15 Jan, 2019, https://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=318&ct=2.

the ship's combat system to calculate an underwater object's position. Plus, some surface ships may have towed arrays and/or helicopters with dipping sonars to improve accuracy with regards to the locations of underwater objects. A surface vessel's only limitation in ASW capability is its fuel; for example, an *Arleigh Burke*-class destroyer's range is 4400NM at 20 knots.¹⁵⁴ Once an underwater object is detected by a surface vessel, the underwater object would have a hard time hiding without going deep because a surface vessel's ASW system would track the underwater object for a long time.

3. Air Assets

Unlike naval assets, air assets have much shorter operation range and time due to limits in flight time. ASW helicopters usually get deployed together with a surface vessel due to their short operation range and time, and ASW airplanes are stationed in strategic locations to execute reconnaissance and surveillance missions in accordance with their higher echelons. A difference between a helicopter and an airplane ASW asset is that a helicopter can hover at a certain location to get better data, but an airplane has to fly continuously since it cannot hover over an area.

a. MPRA (P-8A)

Unlike a helicopter, an airplane needs a runway to take off. Therefore, airplanes need to be stationed in strategic locations. Similar to a helicopter, an ASW airplane utilizes sonobuoys to transmit active sonar signals for detecting underwater objects. For example, the most well known ASW airplanes are P-3C, Orion, and P-8A, Poseidon. They drop sonobuoys in the vicinity of unidentified submarine locations and activate these buoys to determine if there is any underwater object in the area. P-3C's and P-8A's ASW capabilities are similar, but P-8A has a longer range, a faster speed, and a larger load

¹⁵⁴ "USS Chafee," Commander, Naval Surface Force, United States Pacific Fleet, last accessed on 14 Nov 2019, <https://www.public.navy.mil/surfor/ddg90/Pages/specs.aspx>.

capability than P-3C.¹⁵⁵ P-8A has a range of 100 NM, a speed of 490 knots, and utilizes sonobuoys to locate submarines.

b. Helicopter (MH-60)

ASW helicopters usually deploy from a surface vessel's deck because they can only operate for two to three hours, and cannot travel more than 400 NM. For example, a MH-60R usually deploys with a destroyer, and once the destroyer detects an unidentified underwater object, a MH-60R takes off and drops sonobuoys and/or deploys dipping sonars to locate the unidentified underwater object. Similar to a surface vessel, a helicopter is loud when it flies. When a helicopter takes off to perform an ASW mission, any submarine underwater will know an ASW helicopter is in the air looking for a submarine. Nevertheless, with the helicopter's sonobuoy and dipping sonar, which can become active, the helicopter will accurately detect a submarine up to 2500ft deep.¹⁵⁶

C. ASW PERFORMANCE RELATIVE TO ROKN OBJECTIVES

The various ASW assets perform differently depending on the type of mission. The ROKN has both littoral and blue-water navy objectives, with some uncertainty about the relative future weighting of these objectives, as discussed in the previous chapter. Therefore, assessing these ASW assets in accordance with the littoral objective and the blue-water navy objective can not only evaluate the best asset for achieving each objective, but also provide a basis for asset selection that hedges against the uncertainty of which objective may be paramount in future decades.

1. Submarine Suitability for Littoral and Bluewater Environments

This subsection evaluates two basic criteria for submarine suitability for ROKN littoral and blue-water objectives: the range of each type of submarine within the environment, and the duration of each submarine remaining on station in that environment.

¹⁵⁵ Sebastien Roblin, "Why Russia and China Fear America's P-8 Poseidon Submarine Killer," *The National Interest*, 28 May 2017, <https://nationalinterest.org/blog/the-buzz/why-russia-china-fear-americas-p-8-poseidon-submarine-killer-20877>.

¹⁵⁶ "MH-60 SEA HAWK HELICOPTER," United States Navy Fact File, The U.S. Navy, last modified 6 Feb, 2019, https://www.navy.mil/navydata/fact_display.asp?cid=1200&tid=500&ct=1.

According to Vego, “littorals, properly speaking, encompass areas bordering the waters of open peripheral seas, large archipelagoes, and enclosed and semienclosed seas.”¹⁵⁷ Plus, Lindberg and Todd defines littoral as a range from average depth of 250ft to maximum of 600ft and including important areas generally a short distance from land.¹⁵⁸ Additionally, North Korea operated its submarines in as little as 80ft of water to attack the ROK multiple times.¹⁵⁹ By combining these factors, the ROKN’s littoral objective for its submarines can be best defined as the water depth from 80ft to 600ft. Thus, the entire Yellow Sea from the Korean coastline to between 10–50 km away and a part of East Sea from the Korean coastline to 11 km away become the ROKN’s littoral objective area of operation (AOR).¹⁶⁰ The ROKN blue-water objective’s AOR covers outside of the ROKN littoral objective AOR.

Nuclear-powered and diesel-powered submarine options have different capabilities for operating in shallower littoral waters. Table 7 summarizes the minimum depth required for safe operation of these submarine options.

¹⁵⁷ Milan Vego, “On Littoral Warfare,” *Naval War College Review* 68, no. 2 (Spring 2015), 30-68, 4, <https://digital-commons.usnwc.edu/nwc-review/vol68/iss2/4>.

¹⁵⁸ Michael Lindberg and Daniel Todd, *Brown-, Green- and Blue- water Fleets* (Westport: Praeger Publishers, 2002), 66 and 68.

¹⁵⁹ Sebastien Roblin, “North Korea’s Spy Submarines Have Performed Some Wild Missions-But This One Ended In Disaster,” *The National Interest*, 15 Oct 2019, <https://nationalinterest.org/blog/buzz/north-koreas-spy-submarines-have-performed-some-wild-missions%E2%80%94one-ended-disaster-88296>.

¹⁶⁰ Estimated distances calculated in relation to 250ft water depth from the Korean water depth chart (Appedix A).

Table 7. Submarines' height and minimum depth required for a safe operation

Submarine types	Height (including sails)	Required clearance ¹⁶¹	Total depth required for safe operation
KSS-II (Type-214)	13m ¹⁶² (42.65ft)	10.67m (35ft)	23.67m (77.65ft)
KSS-III	14.7m ¹⁶³ (48.22ft)	10.67m (35ft)	25.37m (83.22ft)
<i>Barracuda</i>	15.5m ¹⁶⁴ (50.85ft)	15.24m (50ft)	30.74m (100.85ft)

Based on the information summarized in Table 7, it is clear that nuclear-powered submarines would have a more limited range within the ROK littoral AOR as defined above. (A precise calculation of the exact areas and percentage of the AOR outside a nuclear-powered submarine's range is beyond the scope of this thesis.)

Quantification of both diesel and nuclear submarines on-station duration provides a solid estimation of the effectiveness of both nuclear-powered and diesel-powered submarine options for achieving the ROKN's littoral warfare and bluewater objectives. Diesel-powered submarines take longer time to transit to conserve fuel and battery capacity while nuclear-powered submarines can utilize their maximum speed since they have unlimited fuel supply compared to diesel submarines. However, diesel submarines take less time to refuel and resupply since their on-station time on missions are much shorter than nuclear-powered submarines. Calculations for the comparative on-station availability of both diesel-powered and nuclear-powered submarines for both the littoral and blue-water objectives are provided in Table 8.

¹⁶¹ Adapted from Vego, "On Littoral Warfare," 11.

¹⁶² Adapted from "HDW Class 214-beyond boundaries," Thyssenkrupp, last accessed on 3 Dec 2019, <https://www.thyssenkrupp-marinesystems.com/en/hdw-class-214.html>.

¹⁶³ Adapted from Ridzwan Rahmat, "DSME lays keel for South Korea's first KSS-III submarine," HIS Jane's Defence Weekly, 19 May 2016, <https://janes.ihs.com/DefenceWeekly/Display/jdw61916-jdw-2016>.

¹⁶⁴ Adapted from David K. Dunlop, "Canada's Future Submarines," *Canadian Naval Review*, 25 Sep 2017, <https://www.navalreview.ca/2017/09/canadas-future-submarines/>.

Table 8. Diesel vs. nuclear submarine on-station duration

ROKN's objective	Submarine types	Number of submarines (see Section A)	On-station duration	Transit time	Maintenance and resupply duration	% of on-station per submarine	Number of on-station submarines
Littoral	Diesel	6	2 weeks	1 week	1 week	50%	3
	Nuclear	3	12.5 weeks	0.5 week	4 weeks	74%	2.2
Blue-water	Diesel	6	1 week	2 weeks	1 week	25%	1.5
	Nuclear	3	12 weeks	1 weeks	4 weeks	71%	2.1

*Transit time is only to leave the Korean Peninsula maritime area. If a submarine were to go further, it would take more time.

As demonstrated in Table 8, for achieving the littoral objective the ROKN could have more submarines on station if it were to purchase diesel-powered submarines. For achieving the blue-water objective, diesel-powered submarines provide a notable numerical disadvantage compared to nuclear-powered submarines.

There are certain additional considerations for on-station availability. In achieving the bluewater navy objective, submarines' missions involve prolonged operations to monitor and track other countries' naval assets or deter enemies' naval threats from infiltrating into the ROK's maritime sovereignty. Due to submarines' secretive nature, handing over missions from one submarine to another while they are on station is not favorable because these submarines could be detected while turning over the mission and important information might be lost in the transition. Therefore, the mission's quality may decline and the probability of detection by other countries increases. This factor underscores the small numerical advantage of nuclear-powered submarines for blue-water objectives.

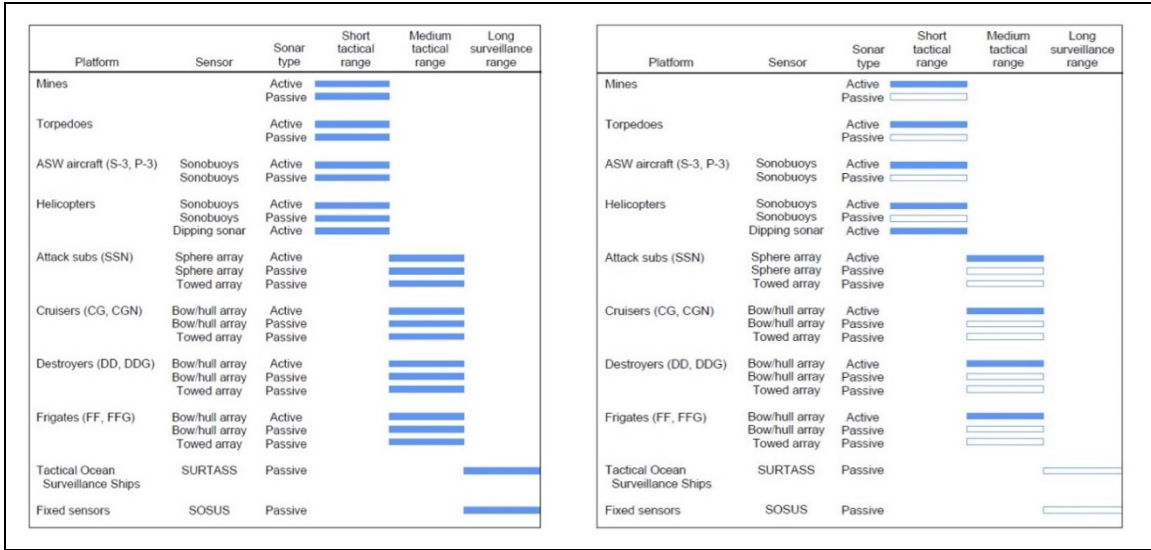
A diesel-powered submarine's availability is higher than a nuclear-powered submarine's in another manner not reflected in the table above. Refueling of a nuclear-powered submarine takes approximately 15–24 months to refit a reactor and certify the submarine.¹⁶⁵ However, a diesel-powered submarine's major engineered overhaul will take less than the nuclear-powered submarine maintenance due to not having a nuclear reactor that requires strict and sophisticated regulations and procedures. Therefore, the opportunity cost while the nuclear-powered submarine is getting refueled, and is thus out of operation, is a huge loss especially for the ROK since they would have very few total nuclear-powered submarines.

2. SONAR Performance against Noisy and Quiet Submarines

A sonar system, whether in passive or active mode, is the essential difference between detection of noisy and quiet submarines. An ASW platform's sonar detection range is usually from a couple thousand yards to tens of miles, mines and torpedoes use up to a few thousand yards, and surveillance ASW systems sonar ranges are in hundreds of miles.¹⁶⁶ Passive sonar equipment can detect a noisy submarine, but it cannot detect a quiet one; active sonar equipment is able to detect a quiet submarine. Figure 1 shows these characteristics in detail.

¹⁶⁵ "SSN-688 Los Angeles-class Engineered Refueling Overhaul (ERO)," Global Security, last modified 7 Jul 2011, <https://www.globalsecurity.org/military/systems/ship/ssn-688-ero.htm>.

¹⁶⁶Gordon D. Tyler Jr., "The Emergence of Low-Frequency Active Acoustics as a Critical Antisubmarine Warfare Technology," *Johns Hopkins APL Technical Digest* 13, no. 1 (1992), 145-159, 152.



Shaded blue means a good performance; blank blue means a poor performance)

Figure 1. Sonar performance against a noisy submarine (left) and a quiet submarine (right).¹⁶⁷

Regardless of ASW platforms, an ASW asset has a higher chance of detecting quiet submarines if the ASW asset uses active sonar equipment to find submarines. As Table 9 displays, although the range and duration of various ASW platforms varies, detection capabilities against quiet submarines do not.

¹⁶⁷ Adapted from Tyler jr. “The Emergence of Low-Frequency Active Acoustics as a Critical AntiSubmarine Warfare Technology,” 153–154.

Table 9. Performance against a quiet submarine¹⁶⁸

Assets	Range	ASW Operation Duration	Cost (\$) per One Unit	Performance	
				Active Sonar	Passive Sonar
MH-60R	Short (<10 NM)	2-3 Hrs	14.3 million	Good	Poor
P-8A	Short (<10 NM)	6-7 Hrs	365 million	Good	Poor
Surface Sonar sys	Medium (<100 NM)	9.17 days	39.3 million	Good	Poor
Diesel submarine (Type 214 class)	Medium (<100 NM)	up to 2 weeks	583 million	Good	Poor
Diesel submarine (KSS-III)	Medium (<100 NM)	up to 3 weeks	900 million	Good	Poor
Nuclear submarine (Barracuda class)	Medium (<100 NM)	unlimited	2.33 billion	Good	Poor

As shown in Table 9, ASW assets differ in their operation duration, cost, and sonar performance; therefore, it is hard to pick the best ASW platform because it depends on the mission and environment. According to Dave Majumdar, “individual ASW platforms would not be working by themselves. The real boost in capability comes from when aircraft such as the MH-60R, P-8A, and Triton work in concert to hunt enemy submarines.”¹⁶⁹ As Hon. John F. Tierney said, “bigger and more advanced military equipment is not always better.”¹⁷⁰ There are cases where nuclear-powered submarines are not suitable to operate, especially when hunting North Korean diesel-electric submarines due to the noise they

¹⁶⁸ Adapted from “MH-60S Fleet Combat Support Helicopter (MH-60S) Selected Acquisition Report (SAR)”, Department of Defense (Washington, DC: Department of Defense, 2014), 30, <https://apps.dtic.mil/dtic/tr/fulltext/u2/1019136.pdf>; “MH-60R Seahawk Multimission Naval Helicopter,” Air Force Technology, last accessed on 14 Nov 2019, <https://www.airforce-technology.com/projects/mh60rseahawk/>; The U.S. Navy, “MH-60 SEA HAWK HELICOPTER”; Sebastien Roblin, “Why Russia and China Fear America’s P-8 Poseidon Submarine Killer,”; “P-8A Poseidon Multi-Mission Maritime Aircraft (MMA),” United States Navy Fact File, The U.S. Navy, last modified 3 Dec 2018, https://www.navy.mil/navydata/fact_display.asp?cid=1100&tid=1300&ct=1; The U.S. Navy, “AN/SQQ-89(V) UNDERSEA WARFARE / ANTI-SUBMARINE WARFARE COMBAT SYSTEM.”; Gordon D. Tyler jr., “The Emergence of Low-Frequency Active Acoustics as a Critical AntiSubmarine Warfare Technology,” *Johns Hopkins APL Technical Digest* 13, no. 1 (1992), 153–154.

¹⁶⁹ Dave Majumdar, “The US Navy Is Preparing to Take On an Old Foe: Stealthy Enemy Submarines,” *The National Interest*, 24 Aug 2016, <https://nationalinterest.org/blog/the-us-navy-preparing-take-old-foe-stealthy-enemy-submarines-17467>.

¹⁷⁰ Committee on Oversight and Government Reform, 111th Congressional Hearings, House of Representatives (July 2010), <https://www.govinfo.gov/app/details/CHRG-111hrg65555/CHRG-111hrg65555>.

generate.¹⁷¹ Also, Figure 1 shows that active sonar is superior in detecting submarines, and platforms dictate whether an ASW asset is in the water, on the water, or in the air. Therefore, a combination platform of an underwater ASW, a surface ASW, and an air ASW would be best in the submarine detection.

For the question of this thesis, these considerations mean that the ROKN's chance of detecting quiet submarines by acquiring nuclear-powered submarines does not increase. A nuclear-powered submarine does not have better capability to detect quiet submarines.

3. ASW Platform Suitability for the ROKN's Objectives

Nuclear-powered and diesel-powered submarine options for the ROKN's maritime objectives can be compared in terms of their suitability for ASW operations, which is the primary concern in either environment.

For the ROKN's littoral undersea warfare objective, diesel-powered submarines are the best asset due to their relatively long operation duration underwater, their greater range within shallower littoral waters, and quietness. Nuclear-powered submarines also have long underwater operation time, however they are noisier and bigger than diesel-powered submarines. Nuclear-powered submarines' operation in the littoral naval warfare, where water depth is shallow, increases their risk of running aground.

Air ASW assets are also excellent in detecting submarines in the littoral warfare, but their operation durations are much shorter compared to diesel submarines. Additionally, they need to coordinate with a surface ship to neutralize a submarine. A team of air assets and a surface ship may form an excellent ASW unit, however the involvement of more units in the littoral warfare may limit their ASW effectiveness without a proper communication and coordination. Undersea threats in the littoral warfare usually involve a single vessel with hidden local enemies; thus, the bigger the ASW force, the more difficult it gets to deter the undersea threat due to louder noise the team generates.¹⁷² Lastly, a

¹⁷¹ Walker and Krusz, "There's a Case for Diesels."

¹⁷² Yaneer Bar-Yam, *Complexity of Military Conflict: Multiscale Complex Systems Analysis of Littoral Warfare* (Cambridge: New England Complex Systems Institute, 2003), 14, <https://necsi.edu/complexity-of-military-conflict>.

surface ship is not the best the littoral undersea warfare because of noise due to the wakes they generate as they sail through the ocean, making their location detectable.

For the ROKN's blue-water navy objective, nuclear-powered submarines have an advantage due to their long underwater operation time and covertness. Surface ships can also achieve the blue-water navy objective.¹⁷³ However, they require frequent resupplies of fuel and other assets' support, cannot operate covertly, and become easy targets of submarines. Diesel-powered submarines have similar capabilities to nuclear-powered submarines and they are quieter than nuclear-powered submarines, but their operation duration underwater is two weeks, at the most. Therefore, diesel-powered submarines have similar limitations to surface ships outside littoral waters. The only limitation of nuclear-powered submarines is food supplies of 70 days. For the same overall cost, diesel-powered submarines would not provide the ROK with quite as much blue-water presence, and there might be some erosion in effectiveness due to a higher rate of mission transition from one submarine to another.

In sum, nuclear-powered submarines have some marginal advantages for the ROKN's ASW operations in a blue-water environment. But diesel-powered submarines have clear and significant advantages for the ROKN's ASW operations in a littoral environment. If the submarines will operate in both environments, the advantage remains with diesel-powered submarines, but less dramatically.

If the ROK has uncertainty as to whether littoral or blue-water environments will be more important in future ASW operations, diesel-powered submarines appear to be advantageous as a hedging choice. This is because their advantages in littoral waters is more dramatic than their disadvantages in blue-water operations, and because the absence of a need for significant infrastructure investment compared to nuclear-powered submarines provides more flexibility for revisiting the choices at a future date.

¹⁷³ Mingi Hyun, "South Korea's Blue-water Ambitions," *The Diplomat*, 18 Nov 2010, <https://thediplomat.com/2010/11/south-koreas-blue-water-ambitions/>.

D. ADDITIONAL CONSIDERATIONS

This section considers several additional issues concerning ROK acquisition of nuclear-powered submarines not yet addressed in this chapter's assessment.

First, acquiring three *Barracuda* class nuclear-powered submarines, at a cost of about \$7 billion, plus the \$2.1 billion cost of the nuclear-powered submarine base, would amount to 21% of the entire \$43 billion ROK military budget for 2018.¹⁷⁴ This calculation does not include these nuclear-powered submarines' operation, refueling, crew training, and nuclear waste costs in ensuing years (described earlier in this chapter). This particularly high percentage of the total ROK military budget for initial acquisition of nuclear-powered submarines would require significant tradeoffs in other military expenditures, at least for one year. Those tradeoffs could affect ROK security priorities in ways that offset any advantages to nuclear-powered submarine acquisition.

Second, nuclear-powered submarines may be useful for the ROK to increase its naval capability against North Korea's SLBM capability. But North Korea's SLBM capability is not yet confirmed.¹⁷⁵ North Korea has not tested a SLBM with a submarine launching platform since 2016, and the SLBM has only been tested in lofted trajectory.¹⁷⁶ Spending 21% of the entire annual ROK military budget on acquiring nuclear-powered submarines in order to prepare against North Korea's unconfirmed capability may hinder the ROKN in obtaining better assets and capabilities towards achieving its objectives. Most of North Korea's submarines are midget/coastal submarines, mainly used by North Korea's Special Operation Force (SOF) infiltration.¹⁷⁷ To hunt down SOFs in midget submarines, which are hard to detect by any type of submarine, would be better accomplished by diesel-

¹⁷⁴ The World Bank, "Military expenditure (current USD)—Korea, Rep.," last accessed on 14 December 2019, <https://data.worldbank.org/indicator/MS.MIL.XPND.CD?locations=KR&view=chart>.

¹⁷⁵ Dave Majumdar, "North Korea's New Ballistic Missile Submarine Proves One Thing," *The National Interest*, 8 Jul 2018, <https://nationalinterest.org/blog/buzz/north-koreas-new-ballistic-missile-submarine-proves-one-thing-25277>; Nuclear Threat Initiative, "North Korea Submarine Capabilities."

¹⁷⁶ James Hackett and Mark Fitzpatrick, "The Conventional Military Balance on the Korean Peninsula," (Washington, DC: The International Institute for Strategic Studies, 2018), 25.

¹⁷⁷ Hackett and Fitzpatrick, "The Conventional Military Balance on the Korean Peninsula," 19.

powered submarines because they are quieter and capable of ranging into shallower littoral waters, as discussed earlier in this chapter.

Third, acquiring such high-tech equipment as a nuclear-powered submarine, and the increased personnel needed in order to operate nuclear-powered submarines, may not align with the ROK government's military reform policies. The latest ROK's military reform, called "Defense reform 2.0," focuses on reducing the number of troops and enhancing land-centric force's basic needs, because the ROK's population has started to decrease and previous military reforms were corrupted by the ROK government acquiring expensive high-tech equipment.¹⁷⁸ Throughout the ROK's military reforms, since 2003, the number of troops was reduced and the level of staffing became the minimum required to achieve the ROK military's security objective.¹⁷⁹ Increasing the number of sailors in the ROKN to man nuclear-powered submarines could cause friction in the ROK government's budget and resistance by public opinion. Also, since many previous expensive military equipment acquisitions wasted the military budget,¹⁸⁰ the ROK military needs to upgrade some of its basic equipment instead of pursuing highly advanced submarines. For example, light infantry army's basic equipment—such as bulletproof helmets and vests, which are relatively cheap compared to ships and fighter jets, are in need of upgrade. If the ROK government pursues acquiring the nuclear-powered submarines, a very expensive military equipment acquisition, the ROK military may be politically scrutinized for increasing the number of troops and wasting military budget for acquiring more than what it requires.

Fourth, the acquisition of nuclear-powered submarines may increase the chance of cyber-attack and espionage from North Korea to steal nuclear-powered submarine technologies and materials. North Korea has the most submarines in the world,¹⁸¹ but it

¹⁷⁸ Chun, "Korean Defense Reform: History and Challenges."

¹⁷⁹ Chun, "Korean Defense Reform: History and Challenges."

¹⁸⁰ Chun, "Korean Defense Reform: History and Challenges."

¹⁸¹ Victor Kiprop, "Countries With The Most Submarines," *World Atlas*, 9 Nov 2018, <https://www.worldatlas.com/articles/countries-with-the-most-submarines.html>; Nuclear Threat Initiative, "North Korea Submarine Capabilities."

only has low quality submarines and not a nuclear-powered submarine because it does not have the financial or supporting infrastructure. North Korea has been modifying one of its submarines in order to launch an ICBM.¹⁸² However, with its limited technologies, its SLBM capability is far from the level of other countries with SLBMs.¹⁸³ North Korea has a demonstrated track record of using cyber capabilities against the ROK. For example, North Korea attempted to hack into the ROK's nuclear power plants to steal, threaten, and release nuclear power information.¹⁸⁴ Thus, North Korea would more than likely attempt to hack into and steal valuable technologies and information since they also want advanced nuclear-powered submarines for their submarine fleet. North Korea's attempt to hack into the ROK's nuclear-powered submarines or their supportive facilities would hinder the operations of these submarines, and strengthening of their cyber defense would be an additional cost to the ROK military's budget. North Korea's attempt to steal these technologies would also affect the public's confidence in nuclear power.¹⁸⁵ Therefore, the ROK government would have to spend more time and effort to convince the public with regards to acquiring nuclear-powered submarines.

Fifth, nuclear-powered submarines carry more severe risks than diesel-powered submarines in terms of any accidents or incidents. If a diesel-powered submarine were to become damaged, the worst that could happen is an oil spill and the crew's injuries and death. However, if a nuclear-powered submarine were to get damaged, radioactive gas or

¹⁸² Kyle Mizokami, "Everything You Need to Know: North Korea's Submarine Fleet," *The National Interest*, 1 August, 2017, <https://nationalinterest.org/blog/the-buzz/everything-you-need-know-north-koreas-submarine-fleet-21739>.

¹⁸³ Majumdar, "North Korea's New Ballistic Missile Submarine Proves One Thing."

¹⁸⁴ "DPRK blamed for cyber attack on South Korean nuclear power plant," North Korean Economy Watch, last modified 26 Mar 2015, <http://www.nkeconwatch.com/2015/03/17/dprk-blamed-for-cyber-attack-on-south-korean-nuclear-power-plant/>; "Intermediate Investigation Result of KHNP Cyber Terror Incident." National Joint Investigation Group on North Korea's Hacking Attack on KHNP, March 2015, http://large.stanford.edu/courses/2017/ph241/min1/docs/min_ref1.pdf.

¹⁸⁵ Sean Lyngaas, "Hacking Nuclear Systems is the Ultimate Cyber Threat. Are we prepared?," Pulitzer Center, last modified 23 January, 2018, <https://pulitzercenter.org/reporting/hacking-nuclear-systems-ultimate-cyber-threat-are-we-prepared>.

fluids could leak out into the environment.¹⁸⁶ Furthermore, if the nuclear-powered submarine crew does not respond appropriately to the reactor casualties, the reactor on the submarine could become a nuclear pressure cooker with radioactive materials, which can release highly radioactive fission products causing a public safety hazard within a mile from the submarine.¹⁸⁷ Submarines are war fighting machines, and if the ROKN is reluctant to use these machines due to risks of reactor casualties, the acquisition of nuclear-powered submarines will degrade the ROKN's ability to achieve its objectives rather than enhancing the objectives.

Lastly, and related, the ROK government may need to spend effort and budget to convince the public that having mobile nuclear reactors floating in the Korean Peninsula maritime area is safe. Since the Fukushima power plant accident in 2011, and the earthquake near nuclear power plants in the ROK in 2016, many Koreans have gained a negative perception of nuclear power.¹⁸⁸ Furthermore, the ROK government's policies made matters worse in relation to nuclear power. According to Se-Young Jang:

The key schism here has been created by the lack of transparency in planning and implementing nuclear energy policy, which has been heavily dominated by key stakeholders including the central government, KHNP [Korea Hydro & Nuclear Power], nuclear academia, and business for several decades. The cover-up of a station blackout incident at the Kori nuclear power plant and the falsification of safety documents for nuclear power plant components are only a few examples among many.¹⁸⁹

The West had a similar situation to the Northeast Asian region's nuclear power experience. The Chernobyl accident in 1986 in the Soviet Union and Three Mile Island accident in 1979 in the United States changed the public's perception of nuclear power. The aforementioned accidents resulted in the United States and European countries

¹⁸⁶ Rob Edwards, "Flaws in nuclear submarine reactors could be fatal, secret report warns," *The Guardian*, 10 Mar 2011, <https://www.theguardian.com/world/2011/mar/10/royal-navy-nuclear-submarine-reactor-flaws>.

¹⁸⁷ Edwards, "Flaws in nuclear submarine reactors could be fatal, secret report warns."

¹⁸⁸ "Country Nuclear Power Profiles: Republic of Korea," International Atomic Energy Agency, updated 2019, <https://cnpp.iaea.org/countryprofiles/KoreaRepublicof/KoreaRepublicof.htm>.

¹⁸⁹ Se Young Jang, "South Korea's Nuclear Energy Debate," *The Diplomat*, 26 October, 2017, <https://thediplomat.com/2017/10/south-koreas-nuclear-energy-debate/>.

enforcing strict rules and regulations in all their nuclear power plants.¹⁹⁰ For example, the United States created an institution called the Institute of Nuclear Power Operators (INPO), after the Three Mile Island accident, to regulate the nuclear power industry.¹⁹¹ The INPO prompted the board of directors in Nuclear Regulatory Commission to fire executives of the Philadelphia Electric utility company when they were discovered to not be following the INPO's rules and regulations.¹⁹² Without transparency, strict rules and regulations, it would be hard to change the ROK public's distrust in nuclear power. In order to gain the public's trust in utilizing nuclear power on the ROKN's submarines, the ROK government would need to spend more effort, time, and money to reconsider the perception of nuclear power. That kind of effort would distract the ROK military from focusing on its objectives.

E. CONCLUSION

The best asset for an ASW mission depends on what kind of objective the ROKN is looking to achieve. If the ROKN's objective is to find an unidentified underwater object at no cost near the ROK's shoreline, a surface vessel with a helicopter would be the best solution. If the ROKN's objective is to find a hostile submarine in the Korean Peninsula maritime area, an ASW airplane would be the best solution. If the ROKN's objective is to monitor the Korean Peninsula coastal lines to conduct undersea warfare as its littoral warfare objective, diesel-powered submarines are the best solution. If the ROKN's objective is to continuously monitor the Korean Peninsula maritime area to deter and deny any undersea threat and project its sea power outside the Korean Peninsula as its blue-water navy objective, nuclear-powered submarines have some merit. But it is not clear that any advantages are worth the risks, especially given the long-term uncertainties of ROK maritime objectives.

Additionally, if the ROK government does not conduct a cost-benefit analysis on these submarines, the ROK military may not have enough funding for the life cycle of a fleet of nuclear-powered submarines. Therefore, without a careful analysis and dedication

¹⁹⁰ Weart, *The Rise of Nuclear Fear*, 242–243.

¹⁹¹ Weart, 242.

¹⁹² Weart, 243.

in acquisition, the ROKN's ability to achieve its objectives may be jeopardized. Nuclear-powered submarines will not strengthen the ROKN's capabilities in achieving the littoral warfare objective, and any increases they provide to the ROKN's capability to achieve blue-water objectives are marginal and qualified. The analysis of a nuclear-powered submarine acquisition also requires the consideration, at a minimum, of spending a fifth of the ROK military's entire annual budget on initial acquisition, the impact on the ROK military's reform efforts, alternate options' costs, the risks of North Korean cyber-attack, public opinion, and actual usage of high priced assets in a risky situation.

This chapter has evaluated the nuclear-powered submarine option in terms of two different strategic maritime orientations for the ROKN—littoral defense or blue-water presence—because ROK policy has swung between these two objectives in the past. Therefore, the ROKN's core objective in the future is uncertain between the littoral and bluewater objectives. While the ROKN has developed better littoral capabilities for its submarines, the ROK's executive branch continues to put effort in creating blue-water navy objective without a clear guidance.

This uncertainty results in part from uncertainty about the North Korean submarines' numbers and capabilities, which would influence the purpose of the ROK's ASW assets. The number of North Korea's submarines range from 64 to 86 submarines depending on the sources of intelligence.¹⁹³ As Table 1 in Chapter 2 showed, the North Korean submarines' number depends on how one categorizes the coastal submarines and semi-submersibles from the obtained intelligence. A greater number of North Korean coastal submarines would induce the ROK submarine force to focus more on the littoral warfare, while fewer North Korean coastal submarines would allow the ROK submarine force to focus more on the open water submarine operations.

The assessment focused on ASW capabilities concluded that, with uncertainty over the long-term commitment to littoral or blue-water objectives, diesel-powered submarines had an advantage as the better option to hedge against uncertainty. The subsequently evaluated additional considerations only add to the risks of seeking nuclear-powered

¹⁹³ Nuclear Threat Initiative, "North Korea Submarine Capabilities."

submarines with uncertain strategic maritime objectives. Nuclear-powered submarines are very sophisticated machines; even an advanced country such as the United States stopped acquiring the *SEAWOLF* submarine in the middle of its acquisition program due to the USN's objectives and high cost. The cancellation of the *SEAWOLF* program cost a lot of money for the U.S. military and hindered the USN in developing a new class of submarines to achieve its objectives.¹⁹⁴ Unless the ROK government and ROK military develop very strong answers to the many concerns over the acquisition of nuclear-powered submarines—including immediate costs, long-term costs, ASW mission effectiveness, impact on the military reform policies, mitigation of the cyber-threat from North Korea, potential unforeseen and hidden costs, public opinion, and cheaper alternatives—the acquisition of nuclear-powered submarines could be a major risk to the long-term security of the ROK.

A final note on the evaluations in this chapter: Due to limited data available in open source, this technical evaluation did not include detailed information on the ROK's ASW platforms. However, the technical evaluation included the most up to date information as possible. For example, the ROK's submarine Type-214 class is a modified version of the Type-212 class by the Hyundai shipyard per the ROKN's requests,¹⁹⁵ and P-8A information is included since the ROK plans to acquire P-8A as their maritime patrol reconnaissance aircraft.¹⁹⁶ Therefore, general information on Type-214 and P-8A are included, but the detailed performance data of Type-214 class and P-8A is not included. Plus, the ROKN's probable nuclear-powered submarine acquisition would be the *Barracuda*-class submarine, and Direction des Constructions Navales (DCNS), a French shipbuilder, modifies the submarine's specification per request. For example, when Australia decided to acquire France's *Barracuda*-class submarine as a non-nuclear-powered submarine, France modified the *Barracuda*-class submarine and changed its

¹⁹⁴ Schank et al., *Learning From Experience*, 56-58.

¹⁹⁵ Naval Technology, "U212/U214 Submarines."

¹⁹⁶ "South Korea Cleared to Buy six P-8A Maritime Patrol Aircraft under \$2.1b Contract," *Naval Today*, 17 Sep 2018, <https://navaltoday.com/2018/09/17/south-korea-cleared-to-buy-six-p-8a-maritime-patrol-aircraft-under-2-1b-contract/>.

classification to *Shortfin Barracuda*-class.¹⁹⁷ Therefore, the technical evaluation only included general information on the *Barracuda*-class submarine without detailed performance data on the submarine.

¹⁹⁷ Ankit Panda, “The Deceptively Simple Reason Australia Picked the Shortfin *Barracuda*,” *The Diplomat*, 2 May 2016, <https://thediplomat.com/2016/05/the-deceptively-simple-reason-australia-picked-the-shortfin-barracuda/>.

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IV. THE REGIONAL SECURITY IMPACT

The ROKN's nuclear-powered submarine acquisition could influence the regional security dynamics in a variety of ways, some positive and some negative. Northeast Asian countries' responses, especially North Korea's and China's, could influence the ROKN's ability to achieve its objectives due to the changed regional security environment. More importantly, the ROK's anticipation of U.S. consent could become the most important issue because the ROK's nuclear-powered submarine acquisition becomes difficult without U.S. consent.

This chapter assumes that the nuclear-powered submarines will not be used for the ROK's littoral objective due to the disadvantages described in Chapter III. The ROKN should realize how the diesel-powered submarines are better platforms to achieve the littoral objective, and the nuclear-powered submarines carry significant safety issues and disadvantages in the littoral missions. Because these disadvantages are evident, even if the ROK were to claim that its nuclear-powered submarines were to perform the littoral objective, other countries would not believe it. Especially, the People's Republic of China (PRC) would be skeptical of the ROK's use of the nuclear-powered submarines in the littoral missions, and it would assume these nuclear-powered submarines are acquired for the ROK's blue-water objective. Therefore, this chapter's discussion of the regional security impact of the ROK acquiring nuclear-powered submarines considers that the ROK and other regional states would all understand that the acquisition is to pursue a blue-water objective.

The ROKN's nuclear-powered submarine acquisition would impact each country in the Northeast Asian region differently because each has a different naval capacity to handle the ROK's nuclear-powered submarines. The acquisition could affect countries to a greater degree if they present more maritime threats and uncertainties to the ROK. The ROK's acquisition could not only affect other countries militarily but could also influence political and economic relationships because military innovation enhances a state's military doctrine, which is a key element that shapes a state's national interests and

objectives.¹⁹⁸ Therefore, the ROK's nuclear-powered submarine acquisition could change the ROK's stance in the region in broader political and economic terms, beyond the pursuit of strategic national objectives.

As mentioned in Chapter II, North Korea poses a direct threat and China poses an indirect threat to the ROK's security due to differences in their naval capabilities' development. China has expanded its naval capabilities the most, at a rapid rate, while North Korea has developed the least naval capabilities, at a slow rate. Therefore, the ROK's acquisition could impact North Korea more and China to a lesser degree.

Compared to North Korea and China, the ROK's acquisition matters differently to the United States. As the ROK's closest military ally, the United States maintains a large military presence in Northeast Asia, so the ROK's acquisition would be important to the United States as much as to the ROK. Therefore, since the ROK requires U.S. consent in its acquisition while the ROK could only anticipate North Korea's and China's responses after its acquisition, the ROK's approach to the United States could be different than the ones to North Korea and China.

The next two sections of this chapter discuss the potential military and political impact of the ROK's acquiring nuclear powered submarines for North Korea and China, respectively. Then the chapter considers the factors that would influence U.S. consent to the acquisition.

A. NORTH KOREA

North Korea would likely react politically and militarily to the ROK's nuclear-powered acquisition depending on how much this would lessen North Korea's submarine capacities used in asymmetric strategies. The North Korean asymmetric capabilities have been direct threats to the ROK.¹⁹⁹ The North Korean asymmetric capabilities include any capabilities used in unconventional way that are perceived differently to target specific key

¹⁹⁸ Barry R. Posen, *The Sources of Military Doctrine: France, Britain, and Germany between the World Wars* (Ithaca: Cornell University Press, 1984), 33.

¹⁹⁹ Seong-Yong Park, "North Korea's military policy under the Kim Jong-un regime," *Journal of Asian Public Policy* 9, no.1 (2016), 57–74, 59.

vulnerabilities and to exploit its most invested capabilities.²⁰⁰ These asymmetric capabilities include cyber capabilities, ballistic missiles, long-range artillery, small submarines, special operations forces, and short-range ground-launched missiles.²⁰¹ When the North Korean military realized that it was inferior to the ROK's military in the 1990s, it developed and employed asymmetric capabilities and North Korean provocations increased in their aggressiveness. As a result, the asymmetric capabilities became critical not only to the North Korean regime, but also to its military strength.²⁰² In the maritime domain specifically, North Korea developed special operations forces in the 1990s and submarines and other naval capabilities in the late 2000s to use as asymmetric capabilities.²⁰³

Additionally, North Korea has been mainly focusing on its military means to pursue its national goals while the ROK has been utilizing other resources to achieve its national goals. According to Posen, "because resources are scarce, the most appropriate military means should be selected to achieve the political ends in view."²⁰⁴ He also mentioned that military means would be used to achieve "the continued survival of the state."²⁰⁵ Therefore, a country is likely to utilize its military to achieve its strategic goals if the country lacks monetary resources. Consequently, military innovation affects national security that is critical to a state's interests.²⁰⁶ As a result, any decrease in North Korea's

²⁰⁰ Joseph S. Bermudez Jr., "The North Korean Military Threat," in *Confronting Security Challenges on the Korean Peninsula*, edited by Bechtol Jr., Bruce E. (Quantico: Marine Corps University Press, 2010), 99-136, 17, <https://www.marines.mil/Portals/1/Publications/Confronting%20Security%20Challenges.%20On%20The%20Korean%20Peninsula.pdf>; Mirko Tasic, "Exploring North Korea's Asymmetric Military Strategy," *Naval War College Review*, Vol 72. No. 4 (Autumn 2019), 53-71, 53-54.

²⁰¹ Tasic, 56; Bermudez Jr., "The North Korean Military Threat," 102; Adam Mount and Andrea Berger, "Report of the International Study Group on North Korea Policy," *The Federation of American Scientists*, 2019, 11.

²⁰² Park, "North Korea's military policy under the Kim Jong-un regime," 66.

²⁰³ Tasic, "Exploring North Korea's Asymmetric Military Strategy," 61.

²⁰⁴ Posen, *The Sources of Military Doctrine*, 13.

²⁰⁵ Posen, *The Sources of Military Doctrine*, 24.

²⁰⁶ Posen, *The Sources of Military Doctrine*, 29.

asymmetric submarine capabilities by the ROK's submarines could induce more North Korean provocations using its other asymmetric capabilities.

1. Military Effect

North Korea would likely react differently depending on whether the ROKN pursues the littoral or blue-water objective because the blue-water objective could reduce North Korea's newly developing asymmetric capabilities while pursuing the littoral objective threatens the developed asymmetric capabilities.

If the ROKN's increase in its diesel-powered submarine's capabilities enhanced its littoral capabilities, North Korea might focus more in developing its new asymmetric capabilities. The ROKN's littoral objective pursuance using its submarines would minimize North Korea's littoral provocations against the ROK, due to North Korea's limited capacity to respond. These expectations are based on several historical examples.

The ROKN's development of military strategies and capabilities due to North Korea's provocations in the early 2000s showed that North Korea's military capacity was limited when compared to the ROK's. When North Korea's surface ships attacked the ROK's ships in 1999 and 2002 in West Sea, North Korea observed its inferiority in naval capabilities against the ROK and how the ROKN changed its posture against the North Korean provocations.²⁰⁷ While these two incidents in 1999 and 2002 showed the ROKN's naval superiority compared to North Korea's, the ROKN's open fire against the North Korean ship that crossed the Northern Limit Line in 2009 demonstrated how the ROK would react against North Korea's naval provocations.²⁰⁸ As a result, North Korea changed its method to provoke the ROK from surface ships to submarines. Hence, the sinking of the *ROKS Cheonan* occurred in 2010 by a North Korean submarine. However, based on how the ROKN responded to the North Korean provocations in 1999 and 2002, North Korea is not likely to attack the ROK using its submarines because the ROKN's

²⁰⁷ Nicholas Macfie, "Factbox: The battles of the Korean West Sea," *Reuters*, 29 Nov 2010, <https://www.reuters.com/article/us-korea-north-clashes/factbox-the-battles-of-the-korean-west-sea-idUSTRE6AS1AL20101129>.

²⁰⁸ Macfie, "Factbox: The battles of the Korean West Sea."

changed military posture and increased naval capabilities based on the events in 1999 and 2002 were clearly reflected in the Battle of Daechung in 2009.

In sum, North Korea would have difficulty reacting to the ROKN's strengthening its submarine force through increasing diesel-powered submarines' capacity because North Korea would have exhausted its naval capabilities that is foundation for its asymmetric capabilities. As a result, it might be more likely to focus on developing new asymmetric capabilities such as ballistic missiles and information warfare than its littoral provocations.

On the other hand, the ROKN's blue-water objective pursuance through nuclear-power submarines might lead North Korea to shift its focus back to littoral provocations. As Chapter III mentioned, nuclear-powered submarines are more expensive and require more sailors to operate. Thus, If the ROKN were to acquire nuclear-powered submarines, it would reduce the number of diesel-powered submarines the ROK could maintain, and the ROKN's littoral capabilities would likely decrease. This would allow North Korea's asymmetric capabilities using its submarines to increase. Moreover, the ROK's submarine acquisition provides a justification for North Korea to develop more lethal military equipment, because according to Denny Roy, "North Korea's policy of intentionally raising tensions with over-the-top belligerent rhetoric and occasional lethal provocations indicates that Pyongyang is not fearful of an imminent U.S. or ROK attack, but rather is confident enough to use threats and intimidation as a strategy for gaining concessions from its adversaries."²⁰⁹

Additionally, the ROKN's nuclear-powered submarines impact on North Korea's development of SLBM capabilities might be minimal. Compared to other North Korean naval capabilities that are operational, North Korea is still developing SLBM capabilities.²¹⁰ North Korea is not deterred in this development by U.S. nuclear attack

²⁰⁹ Denny Roy, "Strategic Ramifications of the North Korea Nuclear Weapons Crisis," in *The North Korea Crisis and Regional Responses*, ed. Uptal Vyas, Ching-Chang Chen, and Denny Roy (Honolulu: East-West Center, 2015), 53-69, 55.; Lisa Collins, "Beyond Parallel: 25 Years of Negotiations and Provocations: North Korea and the United States," Center for Strategic and International Studies, last accessed on 15 Nov 2019, <https://beyondparallel.csis.org/25-years-of-negotiations-provocations/>.

²¹⁰ Joyce Lee, "North Korea says it successfully tested new submarine-launched ballistic missile," *Reuters*, 2 Oct 2019, <https://www.reuters.com/article/us-northkorea-missiles/north-korea-says-it-successfully-tested-new-submarine-launched-ballistic-missile-idUSKBN1WH2GS>.

submarines already present. So it is unlikely the ROKN acquiring nuclear-powered submarines would alter North Korea's SLBM development plans. If so, the ROKN's hope for reducing North Korea's unfinished capabilities would be a waste of time, money, and effort. Therefore, the ROKN's nuclear-powered submarines pursuing the blue-water objective could increase North Korea's littoral naval provocations without gaining any other benefit to compensate.

Lastly, the ROKN could use its diesel-powered submarines to achieve the blue-water objective. As mentioned in Chapter III, the ROKN's diesel-powered submarines could be used to pursue the littoral objective despite their limited underwater operation time and range. In principle, similar to the ROKN's nuclear-powered submarines' case, if the ROKN's littoral capability gets reduced by pursuing both objectives, North Korea could increase littoral provocations. But pursuing both objectives with diesel-powered submarines would allow the ROKN to obtain more total submarines. In this way, if the ROKN were to achieve the littoral and the blue-water objectives successfully at the same time, this would be the worst case for North Korea because the ROKN's diesel-powered submarines would counter North Korea's existing and developing asymmetric capabilities using its submarines.

If the ROK were to achieve both the littoral and blue-water objectives at the same time, North Korea could try to develop a different capability to offset the ROK's diesel-powered submarines. Since North Korea is only rich in military resources, its military innovation is critical to its national interests.²¹¹ In the late 1990s and the early 2000s, the North Korean navy attacked the ROKN's surface fleet four times but did little damage to the ROKN except the sinking of *ROKS Cheonan*.²¹² Through these naval provocations, North Korea learned the ROK military's rules of engagement at sea and its responses against the North Korean provocations. After North Korea gained the asymmetric capabilities along with the ROK military's possible maneuvers and responses, it employed the asymmetric capabilities to display that the North Korean military abilities could cause

²¹¹ Posen, *The Sources of Military Doctrine*, 29.

²¹² Bowers, *The Modernisation of the Republic of Korea Navy*, 29–30.

serious damage to the ROKN. Therefore, North Korea could increase naval provocations to learn the ROK's diesel-powered submarines' abilities and their procedures. North Korea has a secretive nature, therefore, its capabilities are not discovered until they are used. For example, North Korea was able to sink *ROKS Cheonan* because the North Korean asymmetric capabilities' development was and still is secretive due to the lack of intelligence from the ROK and the United States.²¹³ However, North Korea's secretive nature in developing new naval capabilities would decrease significantly due to the ROK diesel-powered submarines' increased ability to achieve both objectives against North Korea at the same time.²¹⁴

2. Political Effect

Possibly the most important potential political reaction is that North Korea could criticize the ROK's nuclear-powered submarine acquisition for interrupting denuclearization of the Korean Peninsula. The ROK, the United States, and international organizations condemned North Korea for acquiring nuclear weapons. But, were the ROK to acquire military equipment with nuclear technologies, North Korea could claim justification for its own nuclear activities and blame the ROK military for disrupting the stability in the Korean Peninsula. North Korea's condemnation against the acquisition could also be another way to strengthen its regime internally.

In fact, North Korea has a record of criticizing the ROK for acquiring advanced military equipment. For example, North Korea announced that it would have to develop a new military capability to destroy the ROK's newly acquired F-35A jets in March 2019.²¹⁵ Similar to how North Korea condemned the ROK's military exercises with the United

²¹³ Seong-Yong Park, "North Korea's military policy under the Kim Jong-un regime," 65-68; "Chronology of Events—DPRK (North Korea)," Security Council Report, last modified 10 Sep 2019, <https://www.securitycouncilreport.org/chronology/dprk-north-korea.php>.

²¹⁴ Richard A. Bitzinger, "S Korean naval shipbuilding: Full speed ahead," *ASIA TIMES*, 30 Jun 2019, <https://www.asiatimes.com/2019/06/opinion/s-korean-naval-shipbuilding-full-speed-ahead/>.

²¹⁵ Josh Smith, "North Korea calls South Korea's F-35 jet purchases 'extremely dangerous action'," *Reuters*, 10 July 2019, <https://www.reuters.com/article/us-northkorea-southkorea-aircraft/north-korea-calls-south-koreas-f-35-jet-purchases-extremely-dangerous-action-idUSKCN1U60BJ>.

States,²¹⁶ North Korea's criticism of the ROK's nuclear-powered submarines could become routine.

Additionally, North Korea could exploit the ROK diplomatically by reviving complaints about the ROK's own minimal nuclear experimentation. North Korea had been scrutinized by the United States and the International Atomic Energy Agency (IAEA) for developing its nuclear weapons program.²¹⁷ In contrast, the IAEA concluded that the ROK's experimentation with plutonium and highly enriched uranium in 1982 and 2000 were only scientific experiments on a small scale.²¹⁸ North Korea criticized the United States and the IAEA that they were holding a double standard and hindering denuclearization of the Korean Peninsula.²¹⁹ Similar to how North Korea responded in 2004, it could not only criticize the ROK for acquiring nuclear-powered submarines, but also criticize the United States and the IAEA. Plus, it could use the ROK's nuclear-powered submarine acquisition as an excuse not to cooperate in denuclearization of the Korean Peninsula.

North Korea's regime could also increase political effort internationally and domestically to distract the ROK and to strengthen its legitimacy, both externally and internally. North Korea does not have the same level of financial or technological means to match the ROK's nuclear-powered submarines.²²⁰ In the 1990s and the early 2000s, North Korea perceived its military inferiority to the ROK and the United States, and sought to gain political and diplomatic leverage by having more bilateral and multilateral

²¹⁶ Simon Denyer, "North Korea denounces scaled-back U.S.-South Korea military exercises," *The Washington Post*, 7 March 2019, https://www.washingtonpost.com/world/asia_pacific/north-korea-denounces-scaled-back-us-south-korea-military-exercises/2019/03/07/b90e7508-40d5-11e9-85ad-779ef05fd9d8_story.html.

²¹⁷ Anthony Faiola and Dafina Linzer, "S. Korea Admits Extracting Plutonium," *Washington Post*, 10 Sep 2004.

²¹⁸ Adam Ward and James Hackett, "South Korea's nuclear experiments: Damaging disclosures," *Strategic Comments* 10, no. 8 (Oct 2004), <https://doi.org/10.1080/1356788041082>.

²¹⁹ Faiola and Linzer, "S. Korea Admits Extracting Plutonium."

²²⁰ Motoko Rich, Choe Sang-Hun, Audrey Carlsen, and Megan Specia, "How South Korea Left the North Behind," *The New York Times*, 6 Feb 2018, <https://www.nytimes.com/interactive/2018/02/06/world/asia/korea-history.html>.

negotiations with them.²²¹ In the late 2000s until 2017, the North Korean provocations increased while negotiations with the ROK and the United States declined significantly.²²² In this period, the strength of the North Korean domestic reform policies' enforcement became weaker than before because North Korea focused on determining the ROK's capabilities and developing its asymmetric capabilities and strategies.²²³ Thus, Kim Jong-Il implemented economic policies to strengthen his legitimacy regardless of the reform policies' outcome while North Korea was developing the asymmetric capabilities.²²⁴ As a result, Kim Jong-Un did not enforce domestic reform policies like his father Kim Jong-Il did because North Korea's asymmetric capabilities such as nuclear weapons and submarines gave more legitimacy domestically and more leverage internationally.²²⁵ Therefore, if the ROKN's submarines were to reduce North Korea's asymmetric capabilities, North Korea could seek diplomatic and political means to strengthen its regime's legitimacy.

Lastly, the North Korean asymmetric strategies could get more creative to prolong the Kim family's regime and unify the Korean Peninsula under North Korea's control if the ROK's submarine force would threaten North Korea's asymmetric capabilities. Chapter III demonstrated that both diesel and nuclear powered submarines could be used in the ROK's blue-water objective. Thus, if any of the ROK's submarines were to reduce North Korea's asymmetric capabilities, North Korea could test the ROK submarine force's capabilities to assess how to develop its new asymmetric strategies. In 2015, 70% of the North Korean submarines deployed at once to see how the ROK military would respond.²²⁶ The ROK military was not able to figure out why these North Korean submarines were deployed until they returned to their respective ports without doing

²²¹ Security Council Report, "Chronology of Events—DPRK (North Korea)."

²²² Security Council Report, "Chronology of Events—DPRK (North Korea)."

²²³ Macfie, "Factbox: The battles of the Korean West Sea"; Kim, Duk-Ki, "The Republic of Korea's Counter-asymmetric Strategy," *Naval War College Review* 65, no. 1 (Winter 2012), 55-74, 57, <https://digital-commons.usnwc.edu/nwc-review/vol65/iss1/4>.

²²⁴ Park, "North Korea's military policy under the Kim Jong-un regime," 66.

²²⁵ Park, "North Korea's military policy under the Kim Jong-un regime," 66-67.

²²⁶ Bowers, *The Modernisation of the Republic of Korea Navy*, 36.

anything. This kind of deployment may seem harmless to the ROK, but this type of military activity may be a probe to test for weaknesses as a precursor of a more aggressive military provocation to follow. Prior to the sinking of the *ROKS Cheonan*, there were multiple naval conflicts initiated by the North Korean navy in the West Sea. Some of these conflicts were small and harmless because they were for the North Korean navy to learn the ROKN's procedures through the ROKN's responses. Therefore, North Korea could build strategies to undermine the ROKN's naval capabilities, so it could advertise its military superiority to strengthen its regime.

B. CHINA

Unlike North Korea, China's military strength is greater than the ROK, so the ROK's acquisition of nuclear-powered submarines would pose less of a threat to China's military or its regime than North Korea's. Therefore, China's response to the ROK's nuclear-powered submarines acquisition would likely depend on how the ROKN utilized these submarines.

The ROKN's focus on a littoral objective with diesel-powered submarines would not likely influence China much. Even if the ROKN were to use its diesel-powered submarines for blue-water objectives, these submarines do not have enough range to cause any significant influence in China.

However, because nuclear-powered submarines are less feasible for a littoral objective, the ROKN's acquisition of nuclear-powered submarines would indicate ROK adoption of a more ambitious blue-water objective. Regardless of ROK declared policies, China would likely expect that the ROKN's submarines would be utilized outside of the Korean Peninsula, to spy on China's strategic assets or monitor maritime trade routes. In this case, China would be likely to react through military, diplomatic, and/or economic means.

1. Military Effect

China would not react militarily against the ROKN's diesel-powered submarines' development if these submarines were to pursue the littoral objective because these

submarines do not pose any significant threat against China. As Chapter III demonstrated, these submarines have less than a week to be on station to perform the ROKN's blue-water objective. Thus, the usage of the ROKN's diesel-powered submarines in the blue-water objective is limited.

China's reaction to the ROK's F-35 and KSS-III acquisitions demonstrate this point well. The KSS-III submarine is capable of launching several anti-ship and land-attack cruise missiles via its vertical-launch system (VLS), and F-35 jets are able to neutralize anti-aircraft and anti-missile defenses.²²⁷ However, China did not criticize or make any statement against the ROK's acquisition of KSS-III and F-35. China's lack of concern indicates that if the ROK's advanced military equipment does not impact China's policy agenda or strategic assets, China is less reactive to whether or not the ROK acquires advanced military equipment. Additionally, the ROK's diesel-powered submarines' engagement with the Chinese naval assets while they are on the littoral objectives is low due to their focus on the North Korean threats. Therefore, the ROKN's diesel-powered submarines would not likely induce a military reaction by China.

On the other hand, China could take military action against the ROK if the ROKN obtained nuclear-powered submarines in order to pursue the blue-water objective. The ROKN's nuclear-powered submarines pursuing the blue-water objective would have a higher chance of lowering China's military and strategic capabilities. As Chapter III demonstrated, nuclear-powered submarines are able to travel far and operate underwater for up to four months. The increased capabilities of the ROKN's submarines would extend their operational ranges outside of the Korean Peninsula maritime area. Plus, these submarines can load more sophisticated military equipment or assets than diesel-powered submarines due to their higher energy output. As a result, China could be nervous towards the ROKN's nuclear-powered submarines operating in the Northeast Asian region. Naval tension between China and the ROK could heighten as the chances of the ROK's submarines getting detected near the Chinese maritime territory also increase.

²²⁷ "South Korea's F-35 fighter jets on display as Moon Jae-in embraces show of strength," South China Morning Post, 1 Oct 2019, <https://www.scmp.com/news/asia/east-asia/article/3031072/south-koreas-f-35-fighter-jets-display-president-moon-jae>.

Consequently, were the ROK's nuclear-powered submarines to disturb any of China's sensitive issues when confronting the Chinese submarines, or appear in a sensitive area in relation to China due to any type of submarine casualty, the military tension between China and the ROK would escalate.

For example, a South Korean warship maneuvered inside twelve nautical miles of the disputed islands in South China Sea for 10 minutes to escape from Typhoon Mangkhut in September 2018.²²⁸ However, the Chinese Ministry of National Defense was disturbed by the fact that the ROK's warship trespassed inside of its claimed territory without the Chinese government's permission even if the ship had to maneuver due to a typhoon.²²⁹ Though this incident ended without mishap, this could have escalated if the ROK's warship had any military objective such as the blue-water objective. Therefore, if the ROK's nuclear-powered submarines were to disturb China in any way, China might alter its military posture, increasing chances it could take military action against the ROK in some similar situation in the future.

In principle, China could take military responses if the ROKN's diesel-powered submarines were to pursue the blue-water objective. Despite the fact that these submarines' underwater operation time is more limited than the nuclear-powered submarines', they can still achieve some blue-water missions. However, China would likely know these submarines' limitations. Therefore, China is less likely to react to the ROKN's diesel-powered submarines than the ROKN's nuclear-powered submarines. If the diesel-powered submarines were to disrupt China by pursuing particular blue-water objectives, China could take military action similar to how it could in the ROKN's nuclear-powered submarine case. But these possibilities are less due to the more limited range of diesel-

²²⁸ Jeremy Page and Andrew Jeong, "South Korean Warship Sails by Disputed South China Sea Islands," *The Wall Street Journal*, 28 Sep 2018, <https://www.wsj.com/articles/south-korean-warship-sails-by-disputed-south-china-sea-islands-1538127139>; Ryan Pickrell, "South Korean Warship runs afoul of China in the South China Sea as the US and its allies up the pressure on Beijing," *Business Insider*, 28 Sep 2018, <https://www.businessinsider.com/south-korean-warship-runs-afoul-of-china-in-the-south-china-sea-2018-9>; Mark J. Valencia, "The Japan-South Korea Maritime Spat: Lessons Learned," *The Diplomat*, 6 Feb 2019, <https://thediplomat.com/2019/02/the-japan-south-korea-maritime-spat-lessons-learned/>.

²²⁹ Page and Jeong, "South Korean Warship Sails by Disputed South China Sea Islands."

powered submarines. Most importantly, the acquisition of diesel-powered submarines would in itself be less alarming to China, due to the types of missions they are suitable for.

2. Political Effect

Similar to how China could take military action, China could take political actions against the ROK if China saw the ROK's acquisition of nuclear-powered submarines reducing China's strategic capabilities. In 2017, when the ROK allowed the United States to deploy Terminal High Altitude Area Defense (THAAD) in the ROK, China criticized the ROK for letting the United States do so. China believed that THAAD's radar could detect China's strategic intercontinental ballistic missiles targeted at the United States.²³⁰ China thought that THAAD was to contain China instead of North Korea because the range of THAAD radar would be more optimal to the distance from the THAAD unit in the ROK to China than to North Korea's missile sites.²³¹ Thus, China retaliated by not letting any Chinese tour the ROK and gave unfair treatment to the ROK companies in China. For example, China's government shut down many of the Korean-owned Lotte stores for violating its regulations. The Chinese government's intention was to show the Korean government that if the Korean government continued to ignore China's demands, then there would be consequences similar to the Lotte company. Since then, the ROK government has advised companies to leave China and move their factories elsewhere in order to prevent China's retaliation.²³² China also punished the ROK diplomatically by halting official military interactions between the ROK and China in the second half of 2016, and meetings between defense ministers and trade ministers of the ROK and China were

²³⁰ Ethan Meick and Nargiza Salidjanova, "China's response to U.S.-South Korean Missile Defense System Deployment and its Implications," U.S.-China Economic and Security Review Commission Staff Research Report, 26 July 2017, 5, https://www.uscc.gov/sites/default/files/Research/Report_China%27s%20Response%20to%20THAAD%20Deployment%20and%20its%20Implications.pdf.

²³¹ Meick and Salidjanova, "China's response to U.S.-South Korean Missile Defense System Deployment and its Implications," 5-6.

²³² Meick and Salidjanova, "China's response to U.S.-South Korean Missile Defense System Deployment and its Implications," 9.

cancelled by China in 2016 and 2017.²³³ Therefore, if China decided that the ROK's nuclear-powered submarines interfered with China's strategic capabilities, China could retaliate using economic means since China would have the upper hand in its economic relation with the ROK.

Additionally, China could strengthen its relationship with North Korea. If China saw the ROK's nuclear-powered submarine acquisition as interfering with its regional interests, China would be inclined to support North Korea even more to be a better strategic buffer between itself and the ROK and the United States, to balance the ROK acquisition. As mentioned earlier, China is the only ally that North Korea has, and China supports North Korea as a buffer state. China supported Kim Jong-Un's succession of the North Korean regime, helped North Korea to build its cyber-warfare capability, protected it from the sinking of *ROKS Cheonan* condemnation, and stopped the combined forces of the ROK and the United States from exercising in the Yellow Sea as a response to the sinking of *ROKS Cheonan*.²³⁴

China supports North Korea to be the buffer state of the United States, but China does not want North Korea to cross China's red line to draw the United States' and its allies' attention to the region. For example, China discussed with Japan and the ROK how to manage North Korea in the regional security perspective in 2011.²³⁵ However, the ROK's nuclear-powered submarines could be used as part of the United States' strategies. China might expect that the ROK would allow the United States to control its nuclear-powered submarines to obtain U.S. consent in the acquisition. As a result, China's reaction to the ROK's nuclear-powered submarines would be from the perspective of the regional security environment among China, Japan, the ROK, and the United States. If these submarines were to execute any operation with the United States that would undermine and destabilize North Korea or threaten China's national interests, China could act as North

²³³ Meick and Salidjanova, "China's response to U.S.-South Korean Missile Defense System Deployment and its Implications," 8.

²³⁴ Paul Lushenko and John Hardy, "China, the United States, and the Future of Regional Security Order—An Unhappy Coexistence," *Asian Security* 12, no.1 (2016), 1-28, 14.

²³⁵ Lushenko and Hardy, "China, the United States, and the Future of Regional Security Order—An Unhappy Coexistence," 14.

Korea's closest ally against the ROK because North Korea's destabilization removes China's strategic buffer.

In sum, the ROK's acquisition of nuclear-powered submarines could induce China to see the Korean situation from a more regional point of view and to strengthen its relationship to North Korea as a counter to both the ROK and the United States. If China were to see the ROK's nuclear-powered submarines as a provocation of China, it could become more tolerant of North Korean provocations of the ROK as a way to balance.

C. THE UNITED STATES

The United States' influence over the ROK's decision-making on nuclear-powered submarine acquisition would affect the ROK more than China's and North Korea's responses. The United States' response to the ROK's nuclear-powered submarines would depend on whether it gives its consent to the ROK in utilizing nuclear materials in its military equipment or not. If the United States were not to give its consent to the ROK, the ROK would not likely acquire nuclear-powered submarines. However, if the ROK were to acquire nuclear-powered submarines without U.S. consent, the ROK-U.S. relationship would likely deteriorate. The likelihood of the ROK's nuclear-powered submarine acquisition without U.S. consent is extremely low, so this thesis does not consider this scenario in the analysis. Even more so than the cost and performance factors discussed in Chapter 3, U.S. consent is the biggest obstacle that the ROK has to overcome for the ROK's nuclear-powered submarine acquisition to make strategic sense.

1. Military Effect

The USN's concern over the ROK's ability to enforce strict rules and regulations in safeguarding nuclear materials and technologies would influence whether or not giving the consent to the ROK's utilization of nuclear material on its military equipment. For example, Canada's clean track record in nuclear power and Canada enforcing the strictest regulations in its nuclear power industry helped in obtaining U.S. consent when it sought

to acquire nuclear-powered submarines.²³⁶ When the United States gave its consent to Canada, a representative of the U.S. Navy Office of Naval Reactors (NAVSEA 08) and a Canadian counterpart discussed for six months how to safely operate Canada's future nuclear-powered submarines.²³⁷ Surprisingly, the area of nuclear nonproliferation was the easiest issue because Canada accepted the very strict terms that the United States proposed.²³⁸ The U.S. representatives' concern was for Canada's private firms to require the same strict and high standards as the U.S. Naval Reactors office.²³⁹

In contrast, the ROK does not possess capabilities to enforce strict nuclear regulations. While the ROK's nuclear power industry has not had a major accident, in 2012 the agencies in charge of the ROK's nuclear power plants were caught in a scandal to allow replacement of nuclear power plants' cables in multiple locations using counterfeit parts.²⁴⁰ Therefore, even if the ROK were to agree to abide by the strictest regulations that the U.S. agencies would require for the ROK to operate its nuclear-powered submarines, the ROK's previous history in relation to nuclear power could weigh negatively on U.S. consent.

Additionally, the possibility of North Korea stealing nuclear technologies and military information from the ROK might also weigh negatively in U.S. consent in allowing the ROK's utilization of nuclear materials in military equipment. As mentioned in Chapter 3, North Korea is not only capable of hacking into well-secured infrastructure such as nuclear power plants, it is also proficient in stealing military information. For example, in 2015 North Korea stole the latest ROK-U.S. wartime operational plan called

²³⁶ Canadian Nuclear Association, *The Canadian Nuclear Factbook 2019* (Ontario: Canadian Nuclear Association, 2019), 6-8 and 74, <https://cna.ca/wp-content/uploads/2018/12/2019-Factbook-EN-digital.pdf>.

²³⁷ Gerald L. Brubaker, "Taking a Dive for a Friend: The Decision to Transfer Nuclear Submarine Technology to Canada," National War College (Washington, DC: National War College, 1990), 8.

²³⁸ Brubaker, "Taking a Dive for a Friend," 8-9.

²³⁹ Brubaker, "Taking a Dive for a Friend," 8.

²⁴⁰ Ju-min Park, "South Korea charges 100 with corruption over nuclear scandal," *Reuters*, 10 Oct 2013, <https://www.reuters.com/article/us-korea-nuclear/south-korea-charges-100-with-corruption-over-nuclear-scandal-idUSBRE99905O20131010>; Max S. Kim, "How greed and corruption blew up South Korea's nuclear industry," *MIT Technology Review*, 22 Apr 2019, <https://www.technologyreview.com/s/613325/how-greed-and-corruption-blew-up-south-koreas-nuclear-industry/>.

OPLAN 5015 that will counterattack the North Korean core military facilities and headquarters if North Korea invades the ROK.²⁴¹ The fact that the plan was stolen only a week after its release as a classified document was both a shock and concern for the United States military in the ROK. Despite the ROK's defense minister's assurance to prevent future North Korean hacking, North Korea's hacking repeatedly occurs.²⁴² North Korea hacked into high ranked South Korean officials' phones in March 2016, and it also hacked into the ROK military's intranet in December 2016 to gain the ROK's classified military information.²⁴³ Therefore, without the ROK's assurance and proof of ability in safeguarding its classified information against North Korea, the United States likely would not give its consent to the ROK.

Lastly, U.S. policymakers would be aware, as discussed in Section A above, that North Korea would likely criticize the ROK's nuclear-powered submarine acquisition for interrupting denuclearization of the Korean Peninsula, and could charge both the ROK and the United States with a double-standard concerning the use of nuclear technologies for military purposes on the Korean Peninsula. Even if U.S. policymakers did not agree with the North Korean position they could oppose the ROK obtaining nuclear-powered submarines if they wanted to avoid this diplomatic impact.

The United States might consider giving its consent if the ROK agrees to operate its nuclear-powered submarines in line with the United States' military strategies in the region. Strategically, the ROK is in a critical location for the U.S. military in relation to China and North Korea. Similar to how the United States allowed the United Kingdom to develop its own nuclear force due to the formulation of allied nuclear policies and cooperation on crisis management, the United States could give its consent if the ROK

²⁴¹ S. J. Choi, "Operations Plan 5015," *The Korea Times*, 7 Oct 2015, https://www.koreatimes.co.kr/www/news/opinion/2015/10/202_188216.html.

²⁴² Dagyum Ji, "South Korea, U.S. to develop new joint wartime operational plans: JCS," *NK News*, 16 Oct 2017, <https://www.nknews.org/2017/10/south-korea-u-s-to-develop-new-joint-wartime-operational-plans-jcs/>.

²⁴³ Ben Wescott, "South Korea blames North Korea for military intranet hack," *CNN*, 6 Dec 2016, <https://www.cnn.com/2016/12/06/asia/south-korea-north-korea-hack/index.html>.

were to follow the United States' strategies.²⁴⁴ In 2017, the ROKN's surface vessels supported the United States' historic three aircraft carriers exercise in the Korean Peninsula maritime area as part of the U.S. strategy to stop North Korea from ignoring the U.S. demands for North Korea's denuclearization.²⁴⁵ The ROK's participation in the exercise demonstrated that if being part of the U.S. strategy benefits the ROK, it would not hesitate to be part of the U.S. strategies. Therefore, the ROK would likely still acquire nuclear-powered submarines even if the ROKN's nuclear-powered submarines have to be part of the U.S. military strategies.

Of course, as discussed in Section B, above, this prospect that ROK nuclear-powered submarines would operate to support wider U.S. regional goals is exactly what would likely motivate China to oppose ROK acquisition of nuclear-powered submarines, regardless of the maritime strategy the ROK proclaimed. U.S. decision-makers would likely take into account this expected reaction by China in determining their own support of the idea. But, despite this reaction by China, the United States might still favor the idea if the strategic contribution was worth the cost of China's opposition.

2. Political Effect

The United States would be hesitant to give the ROK its consent if the ROK were to acquire and develop advanced nuclear technologies from its nuclear-powered submarine acquisition. Historically, the United States did not allow the ROK to acquire or develop advanced nuclear technologies. The ROK tried in 2003 to develop a nuclear-powered submarine program called "362 initiative" to defend the ROK against North Korean threats.²⁴⁶ However, the project was discontinued in 2004 after information was leaked to

²⁴⁴ Nicholas Tracy, "Why does Canada want nuclear submarines?," *International Journal* 53, Vol.53 (Summer 1988), 499-518, 517.

²⁴⁵ Associated Press, "U.S., S. Korea start drills in show of force against N. Korea," *Politico*, 11 Nov 2017, <https://www.politico.com/story/2017/11/11/us-korea-naval-drills-show-force-244803>.

²⁴⁶ Jeong, "South Korea eyes French design for indigenous nuclear sub, sources say"; "SSX-N Korean Atomic Submarine ??", *Global Security*, last modified 4 Mar 2018, <https://www.globalsecurity.org/military/world/rok/kss-n.htm>.

the public because the project brought the criticism of IAEA and the United States.²⁴⁷ Additionally, when the United States and the ROK had to renegotiate the terms for their bilateral peaceful civilian agreement called 123 Agreement in 2015, the United States did not allow the ROK to develop nuclear waste processing technology called pyroprocessing because this technology could be developed to produce nuclear weapons.²⁴⁸ Therefore, the United States is less likely to give its consent to the ROK if the ROK acquires advanced or develops advanced nuclear technologies that could build nuclear weapons.

Relatedly, the United States' allowance of the ROK's nuclear-powered submarine acquisition could set a bad precedent in regards to its nonproliferation. Historically, no U.S. allied country that signed the NPT and a peaceful nuclear cooperation agreement with the United States has ever acquired nuclear-powered submarines. The last 123 Agreement, which the ROK signed with the United States without the terms that allow the ROK to develop and utilize advanced nuclear technologies, implies how the United States is hesitant to let the ROK obtain and utilize such technologies. Allowing the ROK to develop the technologies not only could hurt the United States' non-proliferation efforts in the NPT, but could also demonstrate to other U.S. allied countries that might obtain similar allowance. As a result, the ROK could become a precedent for other U.S. allies that have capabilities and ambitions to acquire nuclear military equipment.²⁴⁹ Therefore, U.S. consent to the ROK for its nuclear-powered submarine acquisition could initiate other U.S. allied countries to follow suit.

On the other hand, the ROK might directly convince the United States' president to give consent to the ROK. The president of the United States can dictate the behavior of U.S. executive agencies and, if needed, can exert pressure to obtain Congressional approval to allow the ROK to use nuclear materials or technologies transferred from the United States for a nuclear-powered submarine program. Canada's case illustrates this point well.

²⁴⁷ Jeong, "South Korea eyes French design for indigenous nuclear sub, sources say"; David Fischer, *History of the International Atomic Energy Agency: the first forty years* (Vienna: International Atomic Energy Agency, 1997), 9–11.

²⁴⁸ U.S. Department of State, "U.S.-Republic of Korea (R.O.K) Agreement for Peaceful Nuclear Cooperation," 20 Jan 2017, <https://www.state.gov/t/isn/rls/fs/2017/266968.htm>.

²⁴⁹ Brubaker, "Taking a Dive for a Friend," 8–9.

Canada was able to obtain U.S. consent in 1988 when Canada was trying to acquire nuclear-powered submarines from either the United Kingdom or France.²⁵⁰ Despite the U.S. Department of Energy (DOE)'s and the U.S. Department of Defense (DoD)'s strong opposition in giving the United States' consent to Canada's nuclear-powered submarine acquisition, Canada's prime minister, Mr. Mulroney, persuaded the United Kingdom's prime minister, Mrs. Thatcher, to pressure the U.S. president, Mr. Reagan, to give Canada its consent.²⁵¹ As a result, President Reagan ended up giving U.S. consent to Canada to acquire nuclear-powered submarines.²⁵²

Therefore, if the ROK were to use its diplomatic and political influence on the United States' president, it might convince the United States to give its consent to the ROK to acquire nuclear-powered submarines. A strong personal relationship between the two countries' leaders could be an important factor that would be distinct from the strategic and cost/benefit analyses of this thesis.

D. CONCLUSION

The ROKN's nuclear-powered submarine acquisition could dramatically influence the regional security environment. The impact will depend somewhat on how the ROKN utilizes the capability. The ROKN pursued both the littoral objective and the blue-water navy objective separately in the past. Ever since the sinking of *ROKS Cheonan*, the ROKN focused on the littoral objective. However, the ROKN seems to remain interested in its blue-water objective.

First, the ROKN's nuclear-powered submarines could make North Korea focus more on the littoral provocations if the ROKN's littoral capabilities decreased due the acquisition. Plus, these submarines influence on North Korea's SLBM capability is questionable since it is not developed yet. Additionally, North Korea could deceive the

²⁵⁰ Philip Shabecoff, "Reagan, Rejecting Navy's Advice, Promises Canada Sub Technology," *The New York Times*, 28 Apr 1988.

²⁵¹ Shaebecoff, "Reagan, Rejecting Navy's Advice, Promises Canada Sub Technology."

²⁵² Shaebecoff, "Reagan, Rejecting Navy's Advice, Promises Canada Sub Technology"; Brubaker, 7.

ROK by cooperating more while strengthening its legitimacy through condemnation of the ROK for hindering Korean Peninsula denuclearization.

On the other hand, the ROKN's diesel-powered submarines, if they were to accomplish both the littoral and blue-water objectives, could drive North Korea to seek new military capabilities. If the ROKN's diesel-powered submarines were only able to achieve the littoral objective, North Korea might spend its effort in strengthening its asymmetric capabilities other than submarines and continue to develop its SLBM capabilities.

Second, the ROK's nuclear-powered submarines could increase military tension between the ROK and China, because these submarines would be purchased to achieve the ROKN's blue-water objective, based on Chapter III's analysis, and so China would likely perceive them as an influence on its regional security beyond the Korean Peninsula. This reaction would be intensified if China believes the ROK's nuclear-powered submarines are executing or assisting the United States' objectives in the Northeast Asian region.

Politically, China could retaliate against the ROK in ways similar to its reaction to THAAD's deployment in the ROK. Plus, China could strengthen its relationship with North Korea to ensure maintain that strategic buffer. On the other hand, the ROK's diesel-powered submarines would not affect China if they were only to pursue the littoral objective. However, if they were to pursue the blue-water objective, China's response would be similar to how it reacts to the ROKN's nuclear-powered submarines, but more moderate due to the limited range of the diesel-powered submarines, and because their acquisition does not signal the same longer-term intentions.

Third, the ROK's nuclear-powered submarine's effects on the United States are different than China and North Korea because the ROK would not be able to acquire nuclear-powered submarines without U.S. consent. Therefore, factors that influence U.S. consent would be more important than the ROK's nuclear-powered submarine's influence on the U.S. Factors that could increase the chance of U.S. consent are the close diplomatic relationship between the ROK and the United States, especially at the president's level,

and the ROK's agreement in allowing the ROK's nuclear-powered submarines to be used as part of the U.S. strategies.

On the other hand, factors that could decrease the chance of U.S. consent are the ROK's lack of strict nuclear regulations, lack of ability to prevent North Korea's hacking, the possible support for developing nuclear weapons, setting a bad precedent for U.S. allies increasing their own nuclear technologies, and hindering the objective of denuclearization on the Korean Peninsula. These negative factors appear to be stronger in current circumstances.

The ROK's nuclear-powered submarine's negative influence in North Korea and China is related to their regimes' legitimacy as well as the countries' security strategies. Based on the past events, North Korea and China could respond aggressively if the ROK's nuclear-powered submarines were to threaten their strategic capabilities. In the United States' case, more negative factors exist than positive ones in influencing U.S. consent to the ROK's utilization of advanced nuclear technologies in its military equipment. Therefore, the United States could risk losing some of its influence in the Northeast Asian region and international non-proliferation regime if it were to give the ROK its consent when the ROK lacks the required abilities. Table 10 summarizes these reactions.

Table 10. Potential military and strategic effects on other key countries of the ROKN's nuclear-powered submarine acquisition

Country	Military Effect	Political Effect
North Korea	(-) Focus more on its asymmetric capabilities other than submarines (Diesel-Littoral obj) (-) Develop a new asymmetric capability (Diesel-both obj) (-) Focus on littoral provocations (Diesel-Blue obj, Nuke)	(-) Distract the ROK to strengthen its legitimacy a. Condemn the ROK for disrupting denuclearization (Nuke) b. Use the ROK's nuke subs as leverage (Nuke) (-) Creative asymmetric strategies (Diesel-both obj, Nuke)
China	(+) No action (Diesel-Littoral obj) (-) Military tension increase (Diesel-Blue obj, Nuke)	(-) Economic retaliation (Diesel-Blue obj, Nuke) (-) Relationship with North Korea strengthens (Diesel-both obj, Nuke)
The United States	(-) Lack of ability to enforce strict regulations (-) Lack of ability to prevent North Korea's hacking (+) Possible use in U.S. strategies	(-) Possible development of nuclear weapons (+) Diplomatic relationship (-) Bad precedence

The main purpose of this chapter has been to consider how the ROKN's nuclear-powered submarine acquisition could influence regional security dynamics. The chapter has found that there could be a variety of impacts, some positive but most negative. North Korea could take advantage of the ROK's reduced attention to littoral maritime security while at the same time attacking the ROK for undermining Korean denuclearization. China would be particularly concerned with the ROKN's nuclear-powered submarine acquisition because it would provide a capability, and signal an intention, to challenge China's regional maritime security interests beyond the Korean Peninsula. The United States could be expected to refuse consent to the ROK in the first place, in part because it would not want to see these effects, and in part because consenting to the ROKN's nuclear-powered submarine acquisition would trigger increased pressure to allow nuclear technology for military purposes to other U.S. allies around the world.

The preceding chapter found that the ROKN's nuclear-powered submarine acquisition would be strategically unwise for a littoral strategy, marginally beneficial for a blue-water strategy, and a poor hedge if the ROK is uncertain which strategy will be more important in future years. The findings of this chapter reinforce the general conclusion that the ROKN's nuclear-powered submarine acquisition would mean committing to strategic directions, and taking on military and political risks, that ROK decision-makers may have not yet fully considered.

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V. CONCLUSION

This thesis has provided an assessment of whether the ROKN's nuclear-powered submarine acquisition could enhance its capabilities to achieve littoral warfare and a blue-water navy objectives, based on the threats and uncertainties the ROK has faced. To achieve these objectives the ROKN is enhancing its diesel-powered submarines and examining the feasibilities of nuclear-powered submarines. The technical evaluation in this thesis has demonstrated that diesel-powered submarines are the most suitable for the littoral objective, and the nuclear-powered submarines are only advantageous to some aspects of the blue-water objective. Furthermore, past events and trends in Northeast Asian regional security show that nuclear-powered submarines would likely face obstacles prior to acquisition and will have negative consequences to the ROK during and after the acquisition. Therefore, although the ROKN's acquisition of nuclear-powered submarines could enhance the ROKN's capabilities to achieve the blue-water objective, these submarines could also bring adverse effects to the ROK. This conclusion chapter combines the findings of this thesis on the ROKN's objectives, technical evaluations, and anticipated impacts on the regional security environment. It then discusses policy implications and future study subjects.

A. PREVIOUS CHAPTERS COMBINED FINDINGS

1. The ROKN's Threats and Objectives

The ROKN has been shifting between the littoral and the blue-water objectives. The ROKN pursued the blue-water navy while the ROK was growing in power, but the sinking of the *ROKS Cheonan* made the ROKN focus on the littoral objective. However, as the uncertainties from China continue to grow while China's military expands and the North Korean threats continue to exist, the ROKN once again seems to be spending effort to achieve the blue-water navy objective on top of its current effort in achieving the littoral warfare objective.

Therefore, ROKN submarine acquisition probably will be guided by some combination of these two objectives. More importantly, ROK emphasis may continue to

shift between the littoral objective and the blue-water objective in ways that are not apparent today, so the ROKN should consider submarine acquisition decisions that are flexible in the future, to hedge against this uncertainty.

2. Technical Evaluation

Through the technical evaluation of various platforms, this thesis determined that the ROKN's littoral warfare objective can be best achieved by diesel-powered submarines, while for the ROKN's blue-water navy objective nuclear-powered submarines have certain advantages even though its diesel-powered submarines could also partially achieve a blue-water objective with operations limited by time and range. From a cost perspective, nuclear-powered submarines are more expensive than diesel-powered submarines. From a performance perspective, nuclear-powered submarines achieve some blue-water navy objectives better than diesel-powered submarines due to their longer underwater operation time and range, but for the same total cost the ROKN could have a greater number of diesel-powered submarines, which might be better for some other blue-water objectives (such as a wider simultaneous presence).

Concurrently, nuclear-powered submarines bring other adverse effects to the ROK and the region. Meanwhile, diesel-powered submarines clearly achieve the littoral objective better than the nuclear-powered submarines. The ROKN's other ASW assets are inferior to either type of submarines because they are noisier and have shorter operation time to detect, monitor, and confront enemy submarines. Plus, they require a close coordination with other ASW assets.

3. Regional Security Environment

The analysis of past events and trends in Northeast Asia indicates that the nuclear-powered submarines would likely result in fewer positive than negative consequences to the ROK. Acquiring nuclear-powered submarines would also be taking higher risks in terms of other countries' possible reactions and potential for crises.

Regarding North Korea, nuclear-powered submarines would provide less littoral maritime security, possibly enabling greater North Korean provocations with its own

current submarine force, while at the same time enabling North Korea to gain diplomatically by criticizing the ROK for undermining Korean denuclearization. Meanwhile, China would probably find nuclear-powered submarines more threatening than diesel-powered submarines, because they would provide a blue-water capability that could affect China's maritime security more directly, and because they would signal ROK intentions to work more closely with U.S. forces to pursue regional maritime security objectives beyond the Korean Peninsula.

Finally, the ROK would spend much effort in obtaining U.S. consent to the ROK's utilization of advanced nuclear technologies in its submarines. If the ROK were to continue with the acquisition without U.S. consent, it would deteriorate its relationship with the United States.

B. POLICY IMPLICATIONS

Presently, the ROKN aims to achieve both the objectives of littoral warfare and a blue-water navy. The North Korean threats require the ROKN to focus on the littoral warfare objective while China's uncertainties and the regional increase in naval and submarine capabilities challenge the ROKN in determining how to counter them. The ROKN's current diesel-powered submarines have been achieving the littoral warfare objective since the sinking of *ROKS Cheonan*, and the development of the ROKN's diesel-powered submarines will further enhance the ROKN's capabilities in achieving the littoral warfare objective. However, a regional-scale blue-water navy objective will be hard to achieve comprehensively without nuclear-powered submarines. Taken together, the ROKN's diesel-powered submarines can achieve the littoral warfare objective although with minimal impact on the region. Furthermore, the ROK's acquisition of nuclear submarines is likely to bring unfavorable consequences to the ROK depending on the scale at which the ROKN pursues a blue-water navy objective.

First, the ROKN does not have to pursue any blue-water navy objective now. The ROKN can continue to increase its submarine capacity gradually. The ROK is currently enhancing its diesel submarine force by acquiring KSS-III, *Dosan AhnChangho* class submarines to ensure its littoral capabilities. For the foreseeable future, the ROK's diesel-

powered submarines are able to achieve the littoral objective against North Korean threats. However, if these submarines were able to achieve both the littoral and blue-water objectives, it would be the worst scenario for North Korea because these submarine would limit North Korea's asymmetric capabilities based on submarines and developing SLBM asymmetric capability.

Similar to how the ROKN is increasing its submarine force by upgrading its diesel-powered submarines gradually, the ROKN can first develop diesel-submarines that have equal or similar capabilities and sizes to the nuclear-powered submarines. Afterward, it can reassess the security environment around the Korean Peninsula and determine whether to pursue the nuclear-powered submarines or not. The past events and trends indicate that there has not been criticism from any country in the ROK's development of advanced diesel-powered submarines such as KSS-III submarines, and these diesel-powered submarines will increase the ROK submarine force's capacity substantially. Plus, diesel-powered submarine technology could advance to the level at which the ROK would not need a nuclear-powered submarine in the future.

Second, the ROK could confine the scope of the ROKN's blue-water objective to the Korean Peninsula maritime area. This would allow the ROKN's diesel-powered submarines to achieve a degree of the blue-water objective because the limited scope is feasible for these submarines. According to Sarah Kirchberger, "[a]part from the U.S., only Russia, France, the United Kingdom, India, Italy, Spain, and Brazil" qualify as true blue-water navies.²⁵³ The concept of a blue-water navy depends on a country's naval capabilities, but despite the ROKN being one of the top five navies in Asia,²⁵⁴ it still lacks the strength and size to be classified as a blue-water navy.²⁵⁵ The concept of a blue-water

²⁵³ Sarah Kirchberger, *Assessing China's Naval Power: Technological Innovation, Economic Constraints, and Strategic Implications* (Berlin: Springer-Verlag, 2015), 69.

²⁵⁴ James Hardy, "The 5 Most Deadly Navies in Asia," *The National Interest*, 9 Jan 2015, <https://nationalinterest.org/feature/the-5-most-deadly-navies-asia-12001>; James Holmes and Toshi Yoshihara, "Understanding Asia-Pacific Sea Power," *The Diplomat*, 21 Oct 2010, <https://thediplomat.com/2010/10/understanding-asia-pacific-sea-power/>.

²⁵⁵ Kirchberger, *Assessing China's Naval Power*, 69.

navy also depends on the maritime partnerships.²⁵⁶ Consequently, the relationship between the ROK and Japan is crucial for the ROKN to be a blue-water navy. The ROK's attempt to become a "true" blue-water navy may generate little positive outcome and much negative outcome due to the resistance it would face from countries like China, and the ROK's lack of naval capacity to overpower its neighboring countries.²⁵⁷ The ROK may also lack the diplomatic influence to collaborate with other countries similar to how the United States cooperates with other strong naval countries when it pursues its blue-water objective.²⁵⁸ Therefore, cooperation between the ROKN's diesel-powered submarines and Japan's submarines might be more beneficial to achieve the ROKN's blue-water objective.

In regards to China, regardless of what types of submarines the ROK acquires, it should adopt clear policies for when its submarines detect Chinese submarines, to avoid escalating tension between the ROK and China. As the ROKN's submarine capabilities increase through technology advancement, the probability of any submarine detection in the Korean Peninsula maritime area is likely to increase. Diesel-powered submarines pursuing the ROKN littoral objective against the North Korean threats are less likely to find China's submarines because the ROK's submarines will operate near the coastal lines of the ROK and the Northern Limit Line (NLL). But the increasing capabilities of the ROK's diesel-powered submarines and their use in limited blue-water missions increases the chance of detection and confrontation. Nuclear-powered submarines will likely have an even higher chance of encountering China's submarines due to their range and underwater operation time while on a blue-water navy mission, increasing the risk of tension between the ROK and China. Therefore, because the ROK is likely to continue improving its submarine capabilities in one form or another, close cooperation and communication between the ROKN and the People's Liberation Army Navy (PLAN)

²⁵⁶ Mingi Hyun, "South Korea's Blue-water Ambitions."

²⁵⁷ Hardy, "The 5 Most Deadly Navies in Asia."

²⁵⁸ Peter Dombrowski, "Is America's Blue-water Navy Doomed?" *The National Interest*, 27 Mar 2015, <https://nationalinterest.org/feature/americas-blue-water-navy-doomed-12486>; Kirchberger, *Assessing China's Naval Power*, 178.

regarding submarine operations will minimize misunderstandings and unintended encounters between their submarines.

Lastly, for the ROK to acquire U.S. consent, it would have to overcome the grand obstacle of obtaining the United States' consent in utilizing nuclear materials in military equipment. It would have to ensure the United States that it is able to enforce strict nuclear regulations, it can prevent North Korea's theft of critical and classified information from its military system, and above all that it would not develop nuclear weapons from the advanced nuclear technologies. Plus, the ROK probably would also need to agree to let its nuclear-powered submarines be used in U.S. strategies, which would mean a closer military and political relationship between the ROK and the United States beyond just the Korean Peninsula.

Because the United States would not likely give its consent to the ROK without utilization of the ROKN's nuclear-powered submarines in its strategies, the ROKN's nuclear-powered submarine acquisition would likely expand the U.S. influence in the region. This in turn will likely irritate China, so the ROK should anticipate China's resentment and retaliation. Similar to how China reacted to the United States' THAAD deployment to the ROK, China is likely to condemn and respond harshly to the ROK because it would know that the ROKN's nuclear-powered submarines will be used to pursue the United States' strategies in the future.

The ROK and the ROKN should be ready to face the aforementioned consequences and other potential unknown domestic and international challenges which may arise if the ROK is to acquire nuclear-powered submarines.

C. FUTURE STUDY

The ROK's acquisition of nuclear-powered submarines would face many obstacles in regards to budget, manpower, public opinion, foreign relations—before, during, and after the acquisition process—prior to the submarines reaching their full operating capacities. Future research can increase understanding of these issues in several areas.

First, future research can increase the precision and the scope of the technical evaluation in this thesis. For example, many estimates of the costs of nuclear-powered submarines for the ROK in this thesis are based on the judgement that France's *Barracuda* class submarine is a likely model for the ROKN to purchase. Similar examination of the the costs of other nuclear-powered submarines in the world could provide a more complete cost estimate for the ROK. As another example, more detailed examination of the types of missions these submarines might undertake for the ROK could increase the precision of cost comparisons that take into account on-station duration. This would be particularly useful to distinguish different scales of blue-water objectives, discussed in the prior section.

Second, future research should compare other countries' experiences in nuclear-powered submarine acquisition and the effects on their countries. The lessons learned and outcomes from these acquisitions can guide the ROK either on how to resolve some of the obstacles, or in making the nuclear-powered submarine acquisition decision in the first place.

Finally, research on how the ROK's domestic factors influence the ROK nuclear-powered submarines' operation would be beneficial. This thesis did not delve into the ROK domestic factors on this issue. But, in terms of the most influential forces affecting decision-making, these matters might have more of an influence than external factors.

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APPENDIX. THE KOREAN MARITIME AREA CHART

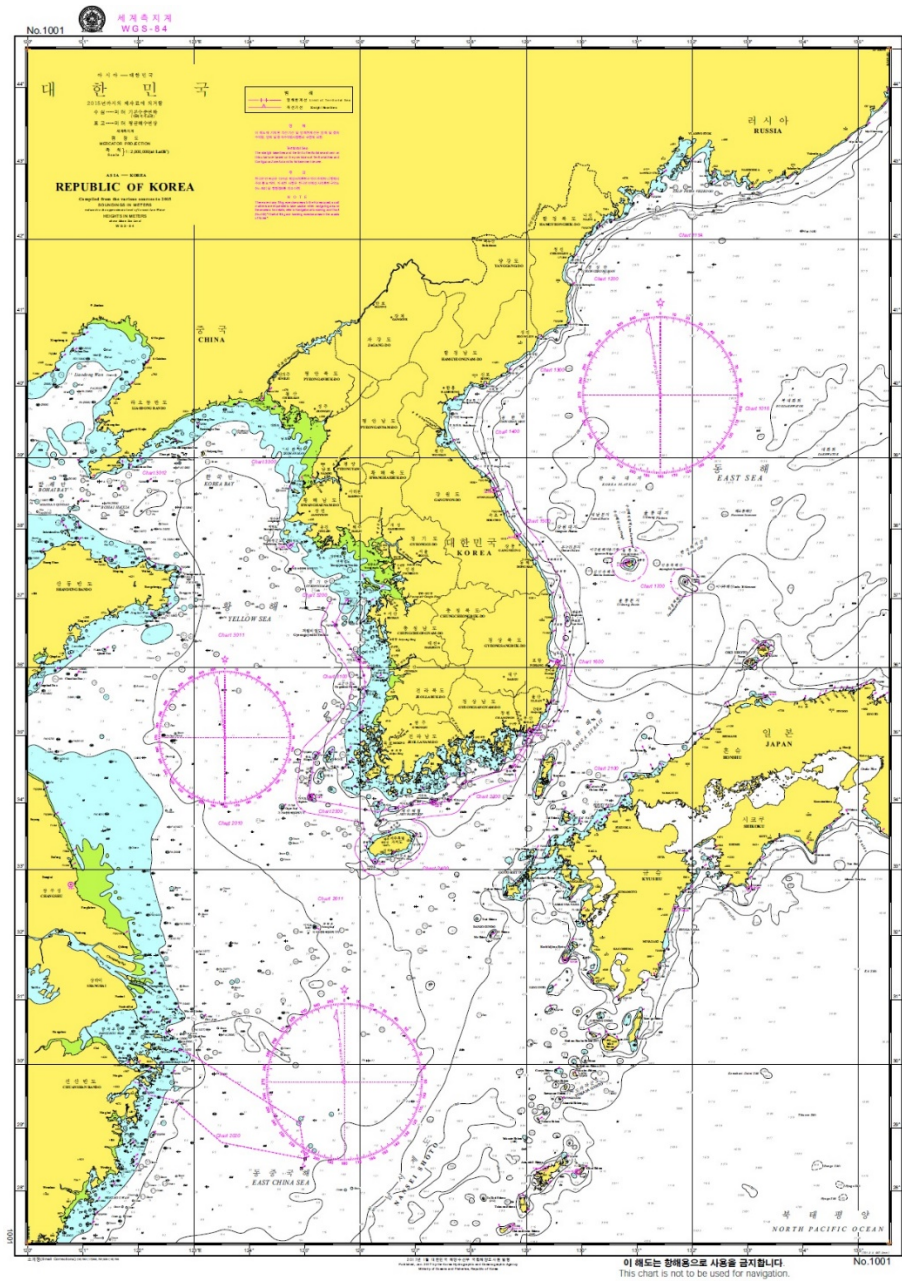


Figure 2. Navigational chart of the ROK²⁵⁹

²⁵⁹ Source: The Korea Hydrographic and Oceanographic Agency, *ASIA—KOREA: REPUBLIC OF KOREA*, 1:2,000,000, World Navigational Chart Series; N1001 WGS-84, Republic of Korea: Ministry of Oceans and Fisheries, 2017, <http://www.khoa.go.kr/eng/images/eastsea/N1001.pdf>.

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