

North Korean Nuclear Capabilities: Past and Present

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Embracing Collaborative Governance: A Paradigm Shift in National Security Strategy

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1. Introduction

North Korea's nuclear capability is developing beyond our expectations. The repeated nuclear and missile tests conducted by North Korea, under the leadership of Kim Jong-un, demonstrate that he considers the North's nuclear capability as one of his major achievements. North Korea has accumulated significant capacities for its economic self-reliance, and it appears that the international sanctions are not very effective in reversing this trend.

Despite international sanctions and economic hardships, North Korea has continued to develop its nuclear capabilities. In 2017, they declared the completion of their nuclear arsenal and enshrined nuclear possession in their constitution. Recently, they have even codified aggressive nuclear weapon use principles through legislation. As a result, the security situation on the Korean Peninsula has significantly deteriorated, leading to strengthened cooperation among South Korea, the United

States, Japan, and China. Therefore, it is necessary to assess North Korea's progress and capabilities in nuclear weapon development, and the threats they pose to us, in order to formulate effective response strategies at this juncture.

2. Socialist Nuclear Development Strategies and the Path taken by North Korea

Indeed, there is a clear dependency in the path among nations during the development of their nuclear weapons, as the information regarding these weapons is highly guarded and kept secret. The United States and the Soviet Union were at the forefront of nuclear development in the early stages of the Cold War. Both countries competed to gain an advantage over each other by closely guarding their own information

and expertise, resulting in the emergence of two distinct paths of technology development.

Drawing upon abundant manpower and resources, the United States took a leading role in nuclear weapons development. They developed atomic bombs based on highly enriched uranium (HEU) produced through the gaseous diffusion method and plutonium (Pu) produced in reactors. Subsequently, they developed boosted nuclear weapons and hydrogen bombs, utilizing lithium (Li) and isotopes of hydrogen (deuterium (D) and tritium (T)). In recent years, they have phased out the energy-intensive gaseous diffusion method in favor of the centrifugal method to produce HEU.

The Soviet Union obtained designs for the implosion-type fission bomb from the United States through espionage conducted by Klaus Fuchs (1911-1988) and conducted its initial nuclear tests using plutonium (Pu). However, relatively early on, they developed the efficient centrifugal method to produce highly enriched uranium (HEU) at a lower cost, reducing their reliance on expensive Pu-based atomic bombs. Additionally, in boosted fission and hydrogen bombs, they mass-produced inexpensive lithium-6 deuteride (Li^6D) based designs and produced only small amounts of costly designs using tritium (T).

These characteristics had a significant impact on the subsequent modernization of nuclear weapons. The United States, by flexibly utilizing advanced implosion devices and tritium, outpaced the Soviet Union in the development of tactical nuclear weapons and miniaturization of nuclear warheads. Technologies related to small tactical nuclear weapons were also applied to special-purpose warheads such as variable-yield warheads and miniaturized hydrogen bombs, as well as neutron bombs. Although the U.S. tactical nuclear superiority was diluted by the 1987 Intermediate-Range Nuclear Forces Treaty, its technological potential still remains significant.

The nuclear technology of the Soviet Union was largely inherited by socialist countries, including China. North Korea also seems to have followed the Soviet Union's path in nuclear weapons development, as they participated in the Joint Institute for Nuclear Research (JINR), led by the Soviet Union, and adopted a Soviet-style research and development system. North Korea initially developed atomic bombs using plutonium (Pu), but due to an inability to mass-produce them, they switched to producing highly enriched uranium (HEU) through centrifugal separators. This is also evident in their reliance on inexpensive lithium-6 deuteride (Li^6D) instead of expensive tritium (T) in boosted fission and hydrogen bombs.

3. North Korean Nuclear Capabilities

1) Production of Nuclear Materials

North Korea has completed a closed nuclear fuel cycle using indigenous resources, including the development of atomic and hydrogen bombs. Now, it is gradually transitioning towards modernizing its nuclear weapons and enhancing tactical performance. With uranium ore reserves exceeding 20 million tons, North Korea can produce approximately 2.9

million tons of yellowcake (U_3O_8) annually at refining facilities. The produced yellowcake is processed into nuclear fuel at the Yongbyon Nuclear Fuel Production Plant and loaded into a 5MWe reactor.

The 5MWe graphite-moderated reactor, which commenced operation in 1986, can accommodate 8,000 nuclear fuel rods and produce approximately 6-7 kg of weapons-grade plutonium (enough for one nuclear weapon) after about a year of operation. Following the sixth nuclear test, experts estimate the remaining amount of plutonium in North Korea to be around 30-60 kg. On the other hand, the production of highly enriched uranium (HEU) through centrifugal separators can vary significantly depending on factors such as the start date of HEU production, and the performance and the capacity of existing centrifuges. The centrifuges are assumed to be of the P2 type, and it is unknown whether the centrifuges employ improved technologies such as the utilization of carbon fiber.

Under the assumptions that: (1) the HEU production in North Korea began before 2010, (2) the estimated number of P2 centrifuges is approximately 4,000 in Yongbyon and over 10,000 in other locations such as Kangson, and (3) taking into account the possibility of high-performance centrifuges based on carbon fiber, the cumulative production of HEU is estimated as follows: (1) approximately 760 kg from Yongbyon, (2) between 1,400 to 2,400 kg, if we include other locations such as Kangson, (3) over 3000 kg with the adoption of improved centrifuges.

Regarding the total number of warheads, several factors need to be considered: (1) the standard amount typically applied to a warhead in HEU is 20-25 kg, and Pu 5-7 kg; while there are possibilities of (2) the utilization of a composite nuclear pit combining both Pu and HEU; (3) the miniaturization of nuclear warheads leading to a reduced use of nuclear materials. Based on these factors, it is estimated that there are (1) approximately 30 warheads from Yongbyon alone, (2) between 70 to 100 warheads including other locations such as Kangson, (3) approximately 200 warheads with advancements in technology. However, many experts estimate the number of warheads coupled with delivery systems to be between 30 to 100.

2) Nuclear Tests and Technical Capabilities

North Korea has announced the purpose of all six nuclear tests conducted so far. That is, the first being an explosion experiment, the second an improvement of explosive power, the third being miniaturization and lightening, the fourth being the development of a hydrogen bomb, the fifth an assessment of standardized nuclear warhead power, and the sixth a hydrogen warhead for intercontinental ballistic missiles (ICBMs). If we accept this as it is, it can be understood that North Korea developed various technical elements until the third test, pursued standardization with the deployment of nuclear warheads in mind with the fifth test, and developed significantly enhancement and boosting with hydrogen bombs in the fourth and sixth tests.

In the end, North Korea announced in the fifth test that they "can produce nuclear warheads as much as they want." This is interpreted to mean that they succeeded in mass-producing weapons-grade highly enriched uranium

(HEU) using centrifuges. "Standardized warheads to be mounted on ballistic missiles" implies the standardization of explosive devices for the nuclear warhead. In other words, they developed a standard explosive device by inserting mass-produced HEU into implosion-type explosive devices developed for plutonium.

In the sixth nuclear test, North Korea announced that it was an H-bomb for ICBMs and unveiled the model of a two-stage detonator and warhead on the same day. This configuration, resembling the Soviet Union's early detonators, which were drum-shaped (peanut-shaped), contrasts with the cylindrical fusion device of the Teller-Ulam design used by the United States. Therefore, it can be speculated that North Korea took the Soviet Union's development path for the hydrogen bomb and detonators. Considering the significant measured explosive power of the nuclear weapons, North Korea has sufficient capability in the development of atomic and hydrogen bombs.

3) Warhead Miniaturization and Missile Deployment

North Korea has claimed to have developed miniaturized and lightweight nuclear warheads in the third and fifth nuclear tests. The miniaturization of North Korea's nuclear warheads appears to have been achieved through several factors: (1) developing missile-mounted warheads from the outset through advanced intelligence, (2) developing alternative materials through indigenous efforts, (3) obtaining modern analytical results through underground nuclear tests conducted at horizontal angles. Therefore, it is without a doubt that North Korea has the ability to mass-produce highly enriched uranium (HEU) while miniaturizing nuclear warheads for actual deployment.

North Korea has been diversifying and modernizing its delivery systems over time. For a long time, North Korea has developed and deployed liquid-propellant missiles such as the Scud, Nodong, and Musudan. Recently, they have developed high-thrust engines in the Baekdusan series using asymmetrical dimethylhydrazine (UDMH) and nitrogen tetroxide (N_2O_4), showcasing missiles like the Hwasong-15 and Hwasong-17 with ICBM-class ranges. However, the absence of a full-scale (end-to-end) flight test for ICBMs raises doubts about their true tactical performance. Additionally, the success of the re-entry vehicle of ICBM warheads still remains uncertain.

Liquid fuel poses challenges such as difficulties in storage, transportation, lengthy preparation times for launch, and complexities in field operations. To overcome these challenges, North Korea is actively developing solid fuel propulsion systems. Solid-fueled missiles offer advantages such as shorter preparation times for launch, easier long-term storage and mobility, and simpler operation. Solid-fueled submarine-launched ballistic missiles (SLBMs) are particularly advantageous as they can be launched stealthily after being deployed from submarines, potentially posing significant challenges to our missile defense systems.

North Korea's recent launches of solid-fueled short-range missiles and large-caliber multiple rocket launchers are also drawing attention. The short-range missiles have demonstrated various flight altitudes and mobility characteristics, while the large-caliber multiple rocket launchers, with approximately

600mm caliber, have sparked interest in whether they are capable of carrying nuclear warheads as claimed by North Korea. Recently, there have been efforts to significantly extend the range of solid-fueled missiles to develop ICBMs. Whether North Korea has developed and applied new high-performance solid propellants such as NEPE, surpassing the conventional HTPB, is also attracting attention.

4) Enhancement of Nuclear Tactics

North Korea, alongside modernizing its nuclear arsenal, has established a strategic force to promote the development of its technical corps and the enhancement of nuclear tactics. In particular, high-altitude nuclear explosions can neutralize radar systems, communication networks, and IT devices over wide areas with powerful X-rays and electromagnetic pulses (EMP), significantly reducing the lifespan of satellites repeatedly passing through the explosion area. Due to minimal heat generation during warhead re-entry, high-altitude nuclear explosions also enable the use of low-performance missiles. Therefore, they pose a particularly large threat to us, given our vulnerability in high-altitude defense systems.

Another noteworthy aspect since 2019 is that some of the ballistic missiles test-fired by North Korea exhibit various "boost-(pull-up)-glide" maneuvers. This capability demonstrates a combination of the speed of ballistic missiles and the maneuverability of cruise missiles. As a result, their tactical utility in modern warfare has significantly expanded. Examples like Russia's Iskander missile and China's Dongfeng-17 (DF-17) represent typical cases of missile warhead maneuvering in socialist countries.

A significant portion of the missiles recently tested by North Korea have been observed to maneuver at altitudes of 30 to 40 kilometers before descending. Experts characterize this as a tactical maneuver that falls between the capabilities of low-altitude interception systems, like the Patriot, and high-altitude interception systems like THAAD. However, modern missile defense systems are closely integrated to address both high and low altitude threats, making it challenging for such missiles to effectively penetrate through the intermediate zone. For missiles like those of North Korea with low apogee altitudes, interception may be easier due to its insufficient energy during re-entry and significant velocity reduction during maneuvering.

4. Recent Developments and Future Outlook

North Korea recently unveiled a new warhead device called "Hwasong-31" with a diameter of approximately 40 to 50 centimeters, along its delivery systems. Compared to the previously revealed spherical warhead, "Hwasong-31" has been reduced in size by 10 to 20 centimeters, sparking interest in the technologies and devices applied. It is speculated that North Korea might have employed technologies such as linear implosion and high-performance explosives used for warhead miniaturization, as well as adopting Pu/HEU composite pits

and tritium addition. However, given North Korea's challenges in mass-producing tritium, its flexible utilization may be difficult to achieve.

The 8 types of delivery systems indicated on the backside illustration of North Korea's "Hwasong-31" include short-range ballistic missiles, medium-caliber multiple rocket launchers, cruise missiles, torpedoes, and others. Since most of these are relatively slow-moving warhead/missile-body integrations, it appears feasible to disperse some guidance/control devices individually across the delivery systems. However, due to the significant variations in environmental factors affecting the diverse delivery systems, it is anticipated that North Korea will pursue diversification of warhead devices for the delivery systems.

Some of the key tasks that North Korea will focus on in the future include the following. Firstly, North Korea will continue to enhance its HEU production capability through centrifuges, as well as sustain Pu production through reactors. Additionally, North Korea will develop even smaller next-generation tactical nuclear weapons, including small hydrogen bombs and advanced warheads with improved warhead devices, high-performance explosives, and added nuclear fusion materials.

Once successful in developing the next-generation small nuclear warhead, North Korea can further diversify the delivery means, including artillery, rockets, small missiles, mines, and portable nuclear devices. Research will continue on developing ICBMs targeted at the United States and on breaching current defense systems. There may be single or multiple nuclear tests to assess the reliability and facilitate mass production of the "Hwasong-31." Additionally, they may also test compact tactical nuclear weapons enhanced with fusion material, and small hydrogen bombs.

5. Countermeasures to North Korea's Nuclear and Missile Threats

The threat posed by North Korea's nuclear weapons can be categorized into several aspects. Firstly, the explosive power of the warheads is increasing. North Korea is believed to be mass-producing standard atomic bombs with yields of around 10-20 kilotons and may add small quantities of boosted fission or hydrogen bombs with yields of 100-200 kilotons. North Korea has been developing fusion materials such as Li⁶ and D since the early 2000s, and mentions of hydrogen bombs in the 4th and 6th nuclear tests suggest the possibility of deploying high-yield hydrogen bombs.

A conventional atomic bomb is considered a tactical nuclear weapon capable of striking small to medium-sized cities or military targets, while the boosted fission bombs and hydrogen bombs exceeding 100 kilotons can be utilized as strategic nuclear weapons capable of incapacitating major cities. If several high-yield nuclear warheads were to strike densely populated cities in South Korea, the nation could face an existential crisis. This implies that we must defend against each and every one of North Korea's nuclear warheads while taking into account boosted fission bombs and hydrogen

bombs.

Secondly, there is an increase in the number of warheads. In contrast to expensive plutonium production, North Korea has the capability to produce a large quantity of highly enriched uranium (HEU). Many experts speculate that North Korea may already possess between 30 to 100 atomic warheads due to this capability. The increase and standardization of warheads mean that North Korea can utilize various delivery systems interchangeably. Additionally, possessing numerous reserve warheads implies the capability to retaliate with surviving delivery systems even after a preemptive strike.

Thirdly, with the diversification and enhancement of delivery systems, North Korea's ability to penetrate defenses is improving. It is believed that North Korea has already equipped miniaturized nuclear warheads on its extensively deployed liquid-fueled short- and medium-range missiles. Recently, by developing solid-fueled missiles and diversifying launch platforms, North Korea has made our response more challenging.

Fourthly, recent missile tests indicate that North Korea is also dedicating significant efforts to advancing its nuclear tactical capabilities. Examples include high-altitude nuclear detonations and boost-glide maneuvers, which pose particularly threatening tactics for IT powerhouses like us with densely populated urban centers. This underscores the intense intellectual battle in missile defense tactics, highlighting the need for meticulous preparation and learning in advance.

Based on the discussions above, several response measures can be proposed. Firstly, meticulous tracking and analysis of the socialist nuclear technology development path are necessary to identify their strengths and weaknesses. Our defense strategies such as the "Korean-style three-axis system" should also be adjusted, taking into account North Korea's development path and characteristics in the medium- to long-term. Moreover, rather than merely keeping up with North Korea's capabilities, it is essential that we actively consider proactive measures to obstruct their progress and hinder the enhancement of their nuclear capabilities.

Equipping ourselves with a robust response system will ultimately minimize damage and lead to victory. We need to revamp our civil defense system focused on defense against aerial attacks, to one centered on nuclear weapons and missile defense. Additionally, it is necessary to develop the required doctrines, compile and distribute various civilian guidelines, stockpile necessary resources, and enhance our response capabilities through regular training. Strengthening the control tower and building internal capacity are also essential. A well-prepared and trained civil defense system can significantly deter North Korean provocations.

Embracing Collaborative Governance: A Paradigm Shift in National Security Strategy

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I . Introduction

The shift from fragmented government to collaborative models represents a significant change in how societies tackle decision-making and problem-solving. Instead of relying solely on centralized authorities or individual actors, collaborative governance stresses cooperation, inclusivity, and shared responsibility among diverse stakeholders. In fragmented systems, decision-making is often isolated, leading to inefficiencies and conflicts. Conversely, collaborative governance aims to bridge these gaps by fostering partnerships and dialogue among government agencies, businesses, NGOs, communities, and individuals. This approach integrates different viewpoints and resources, leading to more effective solutions. Key principles include transparency, inclusivity, mutual respect, and trust-building, empowering stakeholders to contribute meaningfully. Successful examples exist in various fields like environmental management and healthcare, where collaborative approaches enhance innovation and resilience, benefiting communities. The shift towards collaborative governance acknowledges the interconnected nature of modern challenges and emphasizes collective action. This study aims to explore cases illustrating the expansion of national security concerns beyond traditional defense functions. It recognizes that contemporary threats like cybersecurity and pandemics require multifaceted responses, incorporating diverse perspectives and interdisciplinary approaches. By examining real-world examples, the study seeks to deepen understanding of evolving security challenges and the need for comprehensive, adaptive strategies in today's global landscape.

II . Collaborative governance and national security in addressing Korea's social challenges

South Korea is at a crucial point, grappling with a blend of issues that require a comprehensive strategy for lasting progress. Among these challenges, the decline in fiscal

stability poses a significant threat, particularly concerning the nation's ability to maintain core functions like national defense. However, Korea's contemporary landscape is more than just economic; it includes issues such as low birth rates, multiculturalism, climate change, and the rapid advancement of information and communication technology (ICT). To effectively tackle these challenges, South Korea must shift towards collaborative governance, bringing together diverse stakeholders and viewpoints to build a strong foundation capable of addressing social issues while ensuring national security.

This shift acknowledges that traditional approaches to national defense are no longer enough on their own. While maintaining military readiness remains crucial, a broader understanding of security is necessary, one that considers the interconnectedness of social, economic, and environmental factors. By reframing national defense within the context of collaborative governance, South Korea can mobilize collective efforts to tackle the underlying causes of societal challenges, thus bolstering its overall security.

Economic security is of utmost importance as it enables the government to fulfill its duties. Although South Korea was once seen as financially stable among OECD countries, concerns have arisen regarding fiscal soundness. By 2022, the national debt had reached around 50% of GDP, with government liabilities approaching the mid-50% mark. This rise in public debt underscores the need to monitor fiscal sustainability closely, especially amidst global economic uncertainties.

The plummeting birth rates¹⁾ present a pressing concern with profound implications for Korea's demographic landscape and future workforce. To reverse this trend, a collaborative approach involving government agencies, civil society, and the private sector is essential. By implementing family-friendly policies, promoting gender equality, and supporting working parents, South Korea can create an environment conducive to family formation and sustainable population growth. Multiculturalism is another aspect of South Korea's social fabric that requires attention. As the nation becomes

1) South Korea's total fertility rate plummeted to 0.78 in 2022, dropping to 0.72 in 2023, and is anticipated to decrease further to 0.68 by 2024, reflecting a concerning trend of persistent decline.

more diverse, embracing multiculturalism²⁾ becomes not only a matter of social cohesion but also a strategic imperative for national unity and resilience. By promoting inclusive policies, fostering intercultural dialogue, and addressing issues of discrimination, South Korea can leverage its multicultural heritage to strengthen societal bonds and enhance global competitiveness. Climate change presents another existential threat, with rising temperatures and environmental degradation impacting communities worldwide.³⁾ To mitigate these risks, South Korea must adopt a comprehensive approach that integrates environmental stewardship into its national security strategy. By investing in renewable energy, promoting sustainable development, and enhancing resilience to climate-related hazards, South Korea can protect its citizens while contributing to global efforts to combat climate change. The rapid advancements in information and communication technology (ICT) bring both opportunities and challenges for South Korea's security. While digital technologies offer connectivity and innovation, they also introduce risks such as cyber threats and privacy breaches. To capitalize on the benefits of ICT while mitigating risks, South Korea must prioritize cybersecurity, promote digital literacy, and govern emerging technologies ethically.

South Korea's pursuit of a sustainable and secure future hinges on embracing collaborative governance as the foundation of its national security strategy. By recognizing the interconnected nature of challenges, South Korea can foster partnerships, drive innovation, and enhance resilience. Through collective action and shared responsibility, South Korea can address societal challenges while safeguarding national security, paving the way for a brighter future for next generations.

III. Relationships between national security and various fields

From the perspective of collaborative governance, the relationship between national security and various sectors is intricate and interconnected. Collaboration among different fields is crucial to effectively tackle complex security challenges. This involves how different sectors contribute to national security and cooperate within a collaborative governance framework. Transitioning from fragmented to collaborative governance signifies a significant shift in how societies manage decision-making and addressing challenges. Instead of relying solely on centralized authorities or individual actors, collaborative governance stresses the importance of cooperation, inclusivity, and shared responsibility among diverse stakeholders.

2) Between 2012 and 2022, the proportion of multicultural students in South Korean schools surged from 0.7% to 3.19%. Despite an overall decline in student numbers, multicultural student population grew substantially, with an annual growth rate of 13.4%.

3) Korea's Carbon Neutral 2050 plan aims to achieve carbon neutrality by 2050 through a phased approach. The first step targets a significant reduction of 436.6 megatons of CO₂ equivalent, representing 40% of 2018's total emissions of 727.6 megatons. This reduction sets the stage for Korea's commitment to combat climate change and move towards a sustainable future.

The situation in Korea presents complex challenges. With financial sustainability declining, there's an urgent need for national defense to fulfill its primary role. Additionally, establishing cooperative governance is essential to address issues such as low birth rates, multicultural families, climate change response, and advancements in information and communication technology, all of which are crucial for creating a sustainable society. Essentially, addressing social challenges requires a holistic approach where national defense functions are not performed in isolation. By integrating defense efforts with broader societal concerns through collaborative governance, Korea can better address the multifaceted issues it faces, ensuring a more sustainable and resilient future for its citizens. The relationship between national security and various fields is multifaceted and interconnected, reflecting the complex nature of contemporary challenges. Here are some key relationships between security and different domains:

1. National Security and Economic Security:

Security is Korea's top priority, especially as the sole divided nation globally. Geopolitical security, shaped by international relations and diplomacy, is critical. Measures include conflict management, cooperation, and dialogue to prevent confrontations and promote peace. Internally, addressing the reduction in military personnel involves developing next-generation capabilities through R&D and enhancing soldiers' skills.

Economic stability is crucial for national security. Policies fostering sustainable growth, reducing inequality, and promoting innovation strengthen resilience. Achieving fiscal sustainability requires prudent management of government finances, effective tax policies, and strategic resource allocation. Addressing demographic challenges like aging population and low birth rates is essential for sustaining fiscal stability and economic prosperity. Prioritizing fiscal sustainability will bolster confidence among investors and ensure lasting prosperity.

2. Cybersecurity and Information Technology:

With the increasing reliance on digital technologies, ensuring cybersecurity has become crucial for national security. Protecting critical infrastructure, sensitive data, and digital networks is essential to defend against cyber threats and maintain resilience against cyberattacks. Until recently, cybersecurity was mainly the responsibility of the defense sector or National Intelligence Services. However, the landscape has undergone significant changes. While it remains vital for national defense, cybersecurity now extends beyond military purposes and deeply influences society. The rise of cyber threats has elevated cybersecurity to a significant social challenge. Its importance is highlighted by its potential to completely disrupt governmental functions. Recent incidents, such as the paralysis of national administrative computer networks, demonstrate the severe consequences, with citizens unable to access essential civil service documents. Addressing these challenges requires a comprehensive approach involving not just the defense sector but the collective efforts of the entire nation. Collaboration across different sectors is crucial

to effectively counter cyber threats and protect essential systems and services. In this new era, cybersecurity emerges as a potent tool that demands unified action and national-level cooperation.

3. Low Birth Rate and Multicultural Security:

The low birth rate and multiculturalism in Korea are intertwined aspects of national security, necessitating focused planning. Korea's persistent low birth rate poses demographic challenges that could impact economic stability, social cohesion, and national security by straining welfare systems and reducing the workforce. Addressing this requires family-friendly policies and incentives like childcare support. Moreover, Korea's increasingly diverse population, including multicultural families and immigrants, brings both opportunities and challenges for security. Ensuring integration and inclusivity while combating discrimination is crucial for societal stability. Efforts to bolster multicultural security may involve providing tailored language education and social services. Additionally, the decline in military strength due to low birth rates raises concerns about recruitment and societal perspectives on diversity in the military. Proactive measures are needed to ensure equal opportunities for military service, maintaining a robust and diverse armed forces reflective of the nation's demographics to uphold national security.

4. Climate Change and Environmental Security:

Environmental degradation, natural disasters, and climate change pose significant security challenges, necessitating urgent action. Addressing issues like resource scarcity, pollution, and ecosystem decline is crucial for human welfare, social harmony, and geopolitical stability. Climate change exacerbates disasters and food insecurity, emphasizing the importance of initiatives like the Carbon Neutral 2050 agenda and RE100 strategy to mitigate, adapt, and transition to green economies. Economic shifts induced by climate change can lead to food crises and societal instability, potentially sparking refugee crises. Additionally, public health emergencies and pandemics have profound security implications, underscoring the need for robust healthcare systems and international collaboration. Promoting social cohesion, inclusivity, and justice is vital for stability, mitigating the risk of conflict. Diversifying energy sources, advancing renewables, and prioritizing efficiency are essential for energy security, exemplified by Korea's advocacy for CF100 alongside global efforts like RE100.

IV. Collaborative governance provides an alternative strategy for tackling wicked problems

Collaborative governance offers an alternative approach to addressing complex and intricate issues, often referred to as "wicked problems." Instead of relying solely on top-

down or fragmented decision-making methods, collaborative governance prioritizes cooperation and partnership among a diverse range of stakeholders. This includes government agencies, businesses, non-profit organizations, communities, and individuals. By fostering inclusive dialogue, shared responsibility, and innovative problem-solving techniques, collaborative governance recognizes the interconnected nature of wicked problems, understanding that effective solutions often require collective action and diverse perspectives. Through collaborative governance, stakeholders can work together to address wicked problems in a more comprehensive, creative, and sustainable manner, ultimately leading to solutions that are more effective and enduring.

1. Shifting Perceptions to Address a Rapidly Changing Security Environment

Since the 1990s, there has been a rapid spread of ideas regarding the future of governance encapsulated in slogans like "From Government to Governance," "Governance Without Government," and "Growth Without Governance," primarily within relevant institutions and academia. This dissemination views governance as embodying all the necessary changes for government reform, surpassing the traditional notion of government. This shift involves adopting a fresh outlook beyond conventional government frameworks, involving the delegation of overlapping tasks in policy-making, optimization of budgetary allocations, relief from fiscal pressures, and responsiveness to administrative service needs⁴⁾

Essentially, governance has emerged as an alternative concept necessitating a thorough overhaul of existing government operations. Similarly, significant shifts have occurred in the national security landscape. While there is a trend towards comprehensive security in the defense sector, it remains largely rooted in traditional defense-centric security strategies. There is an urgent need to boldly transition from fragmented roles and functions to a collaborative governance framework. This transition is crucial because various contemporary challenges such as low birth rates, multiculturalism, and climate change are directly intertwined with national security. Therefore, addressing societal challenges requires diverse functions and mutual cooperation. For example, the 4th Comprehensive Plan for Low Birth Rates and Aging Society (2021-2025) (hereafter, Comprehensive Plan) involves multiple ministries with a total budget of approximately 72.7 trillion won as of 2021.

To illustrate, low birth rates and aging societies are primary concerns. Among these, low birth rates directly impact defense, thus necessitating a role for the Ministry of National Defense. However, defense functions are not explicitly designated for this purpose. Addressing challenges at a national level is imperative; relying on a few central ministries to tackle societal challenges is insufficient. Hence, there is a need to move away from the simplistic notion that financial injections alone can resolve issues, and instead recognize the necessity of defense research and development (R&D) to address declining military personnel, as well as the need for careful consideration in the education division for children

4) Jeong Seongho, "The Effect of Governance on Economic Growth," *Korean Journal of Public Administration* 19, no 3 (September 2010): 171-202.

from multicultural families who are expected to join the military. Furthermore, climate change presents multifaceted crisis factors, requiring collaboration across various fields.

2. Moving Beyond Traditional National Security: Intergovernmental Relations (IGR) Perspective

Traditional security refers to the idea of defense security centered around the state. As society becomes more diverse, the concept of comprehensive security has emerged from traditional notions. Essentially, security has broadened beyond defense to encompass various domains like politics, economics, society, science and technology, and the environment. However, the challenge lies in significantly departing from traditional security practices. Individual ministries persist in the old approach of formulating policies through budget allocations. Despite the apparent cooperation among ministries in initiatives like the Comprehensive Plan, in reality, these ministries are pursuing policies in a fragmented manner. For example, addressing low birth rates and multiculturalism are significant government agendas in their own right. Despite their close link to defense capabilities, the Ministry of National Defense (MND) is notably absent from even the Comprehensive Plan. Additionally, climate change serves as a driver of disasters, environmental shifts, energy crises, and food shortages, necessitating a coordinated response across agencies. Climate change response isn't solely the responsibility of specific ministries; it requires a national-level approach, with the defense sector also playing a vital role. While implementing green policies within the defense sector immediately may face limitations, it's crucial to create a long-term strategy to identify actionable areas promptly. Therefore, diverse collaboration is vital to tackle societal challenges.

3. Strategic Resource Allocation through Collaborative Governance

Many developed nations, including South Korea, are grappling with prolonged periods of low economic growth. Despite South Korea's commendable reputation for maintaining robust finances within the OECD, recent trends indicate a deteriorating fiscal balance, raising concerns about long-term sustainability. A fundamental shift is needed from the traditional approach of fragmented functional performance towards a more integrated and collaborative governance system. This transition is crucial for effectively addressing a myriad of societal challenges. It necessitates moving away from the current practice of allocating resources based solely on individual ministries' priorities towards a cross-agency, priority-centered expenditure system. Examining initiatives like the Comprehensive Plan, it may appear that policies are being driven by several central ministries. However, in reality, individual ministries autonomously pursue tasks using allocated funds, leading to suboptimal outcomes. A common pitfall is the reliance on committees to drive policy initiatives. Should a committee be established, such as the Low Birth Rate and Aging Society Committee, it is imperative to assign

a controlling ministry responsible for ensuring efficient financial execution and performance evaluation. Despite the establishment of numerous committees and substantial annual budget allocations, tangible results have not been forthcoming. It underscores the critical role of finance as the cornerstone of policy implementation and the importance of adopting a sustainable approach. This entails addressing complex societal challenges, particularly climate change.

V. Conclusion

As society rapidly evolves, so does the security landscape. While the government traditionally focused on traditional security, it now seeks comprehensive security to address the changing societal dynamics. However, there are concerns about the government's approach possibly being too formalistic. In essence, while there has been a formal expansion of security beyond traditional boundaries, there are limitations to its practical implementation. Achieving comprehensive security requires cooperation not only among central government agencies but also between central and local governments, as well as between the public and private sectors. This collaboration is essential for building a sustainable future society. It underscores the importance of diverse stakeholders working together, which is the essence of collaborative governance.



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