A preliminary study for establishing a monitoring system for undeclared nuclear programs using Open-Source information

JaeMin Lee, JungHee Son, Jooho Whang
Nuclear Engr., Kyunghee Univ., Global Campus, 1731, Deogyeong-daero, Yoengtong-gu, Suwon-si, Gyeonggi-do, Korea, 16710
*Corresponding author: joohowhang@khu.ac.kr

1. Introduction

4.27 Inter-Korean summit and 6.12 North Korea–United States summit are raising expectations for denuclearization of North Korea. The Korean government emphasizes that denuclearization of North Korea is the most important factor for peace on the Korean Peninsula. In this international situation, Korea should make preemptive preparations for the nuclear disarmamentand verification of the North Korean nuclear program. There are many ways to identify North Korea's nuclear programs, but the primary method is to use open-source information. US non-governmental organizations such as ISIS, 38 North, and NTI have been using open-source information effectively for years. However, Korea lacks a non-governmental organizations that uses and analyzes open-source information.

In this study, we briefly introduce how to collect and analyze open-source information related to North Korea's nuclear program. And as a result of subsequent research, we propose a North Korean nuclear program monitoring system for peace on the Korean peninsula.

2. Methodology for open-source information collecting

2.1 Information collection using the Internet

The most common way to obtain open-source information is to collect via internet. However, information collected via internet is less accurate, and its contents are likely to be corrupted or distorted. Even a person whose source has not been confirmed may deliberately disseminate misinformation on the internet, or misinterpretation may change their meaning. Therefore, it is essential to verify the accuracy and reliability of the information collected through the internet.

All information obtained over the internet must identify the primary source and the authors' interests. Because of this characteristic, open-source information is not used alone, but is used to verify the authenticity of other information or mixed with other information. The following table describes some points to note when gathering internet information.

Table I: Challenges for information collection

Challenges	Description
Insufficiency of information	Nuclear development countries generally control information in unit of state
overabundance of information	There is a lot of information on the internet and it is necessary to edit the collected information.
Verification of information	There is a possibility that the accuracy is low and the information is distorted depending on the viewpoint
Language problem	Most of the details are written in the language of each country
Analysis of information	After collecting information, systematization, correlation analysis, estimation, draw a conclusion are needed

Google, Naver, Yahoo, etc. are commonly used as a search engine when searching the Internet. However, experts use search engines or software that have many functions when searching the Internet. Search engines have different search mechanisms. Therefore, it is effective to utilize various search engines because search result may be different even if someone search the same topic. Table 2 shows search engines and their functions.

Table II: Internet information search engine

	Description
[1]Google	Provide a search service that can be used conveniently by systematizing information from all over the world
[2]Yahoo	Small database. but provides good search results
[3]IBM Watson Explorer/[4]Yippy	Automatically determine topics in search results and collect results in self-defined categories

[5]Kartoo	Graphical representation of relationships between search results
Search Engine	Search engine evaluation sites that provide testing, ratings, and reviews for search engines such as Watch(https://searchenginewatch.com), Showdown(http://searchengineshowdown.com)

[1]https://www.google.com/
[2]https://www.yahoo.com/
[3]https://www.ibm.com/products/watson-explorer
[4]http://yippy.com/
[5]http://www.kartoo.com/

2.2 Local database

In order to effectively use the collected open-source information, it is important to build a customized local database for the purpose of use. The information in the local database is less likely to be compromised and stable compared to information on the internet. Information that is built into the database to suit the purpose of use is useful for future information analysis.

Open-source information can exist in various inconsistent forms such as text files, books, and photo images, it is necessary to use software to manage them uniformly.

3. Methodology for open-source information analysis

3.1 Analyzing science and technology capabilities

Analyzing the capacity of a country's science and technology is a useful way to find research patterns that do not match national report or to find clues to undeclared nuclear activities. In addition, the information collected can be used to design effective economic sanctions, import and export control systems that can curb nuclear weapons programs.

The development of nuclear weapons requires not only nuclear engineering but also diverse expertise such as chemical engineering, mechanical engineering, numerical modeling, and project management. Therefore, for the analysis of science and technology capacity, the status of technology development in various fields and their interrelationships should be analyzed. A list of specific nuclear proliferation technologies associated with this can be found in the following sources.

- The Nuclear Section of the U.S. Department of Defense's Militarily Critical Technologies List (MCTL)[2]
- The Nuclear Suppliers Group (NSG) export control guidelines supplemented by special attention to three areas:

 - Fluorine chemistry expertise, especially on an industrial scale (critical for all UF_4 and UF_6 based uranium enrichment processes)
 - Computerized numerical modeling capabilities, especially those involving shock wave physics, hydrodynamics, and radiation transport (normally Monte Carlo based)
 - Capability in precision high explosive work such as the development of shaped charge munitions and precision timed initiators
- The NSG Guidelines for the Export of Nuclear Material, Equipment and Technology (INFCIRC/254, Part 1)[3]
- The NSG Guidelines for Transfers of Nuclear-related Dual-use Equipment, Materials, Software and Related Technology (INFCIRC/254, Part 2)[4]

In the above list, the scientific research results of the designated technical field are analyzed to determine the capability of the country in the science and technology. The most representative information gathering tool for nuclear technology non-proliferation research results is IAEA International Nuclear Information System (International Nuclear Information System, INIS / https://inis.iaea.org), a public information database of IAEA. INIS provides various forms of information, including reports, minutes, and patents, as well as scientific research papers, and supports multilingual search systems.

Also there are other science and technology database systems like ProQuest DIALOG (formerly Thomson Dialog / www.proquest.com), Elsevier's Science Direct (www.sciencedirect.com), Google Scholar (https://scholar.google.com).

3.2 Analyzing commercial satellite imagery

Satellite images are one of the tools for nuclear activity detection and verification. Satellite images can observe the areas that are difficult to access geographically and politically, and it is advantageous to obtain time series data for a wide area.

Analysts with years of video experience and skills are needed to identify and locate nuclear facilities through commercial satellite image analysis. Image analysis also requires an in-depth understanding of the nuclear fuel cycle and weapons-related infrastructure, and in many cases requires a very comprehensive knowledge of the country's overall industrial development and political implications.

In order to detect concealed nuclear facilities using commercial satellite imagery, we focus on nuclear facilities that have identifiable physical properties and easily observable. For example, a large-scale uranium enrichment facility is characterized by a heat transfer / cooling system and a large manufacturing space, and nuclear reactors can easily be identified by containment buildings and cooling towers. However, some activities,

such as gas centrifugation, may not have readily identifiable physical properties.

4. Case for open-source data analysis

4.1 Case of open-source information analysis

Analyzing open-source information is the first thing to do for undeclared nuclear program monitoring. In the case of the detection of undeclared nuclear programs, the detection of China's nuclear weapons test site in 1964 (US CIA Corona), the discovery of the Kalahari nuclear test preparation in the Soviet Union in the late 1970s, the detection of North Korea's underground nuclear test facilities in the early 1990s.

In this chapter, we briefly introduced the case of actually using open-source information for verification of nuclear program. In 2005, resistance of Iran held a press conference to reveal Iran's nuclear activity. The information presented at the press conference was verified using Google Earth and commercial satellite imagery. The Iranian resistance group revealed at the time of the press conference that there were nuclear missile production facilities under the Kuh-e Barjamali peak east of Tehran, revealing three tunnels entering the underground base. And reveal a drawing showing three tunnel entrances connected to an underground station. After the press conference, some organizations used commercial satellite imagery to verify the authenticity of the revealed drawings. The verification results revealed that there is a fourth tunnel entrance. In addition, the fact that the shape of the missile test facility on the satellite image resembles that of North Korea, suggests that North Korea might have been involved in Iran's nuclear development. These examples show that it is more effective when collecting and analyzing multiple open-source information collectively then each open-source information is utilized separately. In addition, it can be seen that analyzing open-source information can produce another new information. [1].

4.2 Case of organization using open source information

In this chapter, Cases of open-source information collection and analysis institutions in the United States was introduced briefly. This cases can be a useful reference for establishing an undeclared nuclear program monitoring system by analyzing similar cases of open source information system and local data base.

38 North is a website devoted to informed analysis of North Korea. It links with various experts to analyze North Korea's weapons of mass destruction, military, economic and social conditions, and periodically releases the results of information analysis to the general public. ISIS (Institute for Science and International Security) is a non-profit, non-partisan institution Think-Tank. ISIS aims at enhancing

transparency of nuclear activities around the world and strengthening the international non-proliferation regime. It collects and analyzes information on North Korea as well as various countries. And distributing its findings and analysis to the general public, scientists, experts, the media, and the general public. Nautilus Institute is public policy think-tank dealing with international political and security issues related to US nuclear policy to reduce the risk of nuclear war. Nautilus Institute forms human networking for professional collaboration and global network built serving thousands of people in over fifty countries. NTI (Nuclear Threat Initiative) is also a non-profit organization that works with governments, partner organizations and leaders around the world to reduce dependence on nuclear weapons, prevent nuclear proliferation.

Table III: Comparing open-source information analytics Institutions in the US

Institute	Staffs	Analysis information					
		Satellite	Facility	Industry	Defense	Weapon	Reports
[1]38 North	182 (Author)	O	O	×	O	O	O
[2]ISIS	6(Staff)	O	O	×	×	O	O
[3]Nautilus	6(Staff)	×	×	×	×	×	O
[4]NTI	45(Staff) 49 (Advisors)	×	×	×	×	O	O

[1]https://www.38north.org/
[2]http://www.isis-online.org/
[3]https://nautilus.org
[4]https://www.nti.org/

5. Conclusions

In this study, Information gathering method through internet, local database, institutions and examples using collected open source information was introduced. It is important to verify the accuracy and reliability of open source information that is low in accuracy and can be distorted by interest. However, there is no system for mutual verification of North Korean nuclear programs using open source information. Even if some open source information is available in Korea, there is a lack of organizations to monitor and analyze North Korea's nuclear programs systematically using experts such as the previous case (38 North, ISIS, NTI, etc.). In future research, we propose a plan to establish a monitoring system for undeclared nuclear programs based on information gathered through various channels, analytical data collected by experts, and US NGO organizations' monitoring program case.

6. Acknowledgement

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