

Evaluation of Double Base Propellant Industry Independence, Using Swot Analysis, Supply Side

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Abstract

Until now, Indonesia is still importing Double Base Propellant (DBP) for the ammunition and rocket industry. It causes the Indonesian Defense Industry to not be independent. On the other hand, DBP raw materials are abundant in Indonesia. Cellulose and Glycerin are produced from plants or micro-organisms that contain lots of fiber and oil. Therefore, the purpose of writing this paper is to build on the above conditions through a Strength, Weakness, Opportunity, and Threat or SWOT analysis. Starting with the search for data references, then followed by the implementation of workshop activities and discussions and in-depth interviews with experts to find the depth of the data and the assessments of these experts. The SWOT analysis findings provide a perspective and map of the relationship between SWOT elements and alternative action plans. Discussions on building strengths, minimizing weaknesses, looking for opportunities, and countering threats, resulted in recommendations for prioritizing the preparation of a roadmap for the independence of the propellant raw material and the raw material industry dedicated to the propellant industry.

Keywords

double base propellant, cellulose; glycerin; SWOT analysis



I. Introduction

One of the national programs in the defense sector is the propellant. The propellants discussed in this paper are limited to the type of Double Base Propellant (DBP), namely, Nitro Cellulose enriched with Nitro Glycerin and added with additives. In manufacturing, according to the form of production, it is divided into 3 types, namely Spherical powder, Extruded Double base, and Cast Double base. The current demand for DBP propellants is still entirely obtained from imports, with projected propellant needs in 2025, namely 400MT for Spherical Powder and 80 MT for Extruded Double Base, and will increase by 70% in 2045. Nitro Cellulose and Nitro Glycerin are obtained from the nitration of cellulose and glycerin. The raw material is plentiful in Indonesia. Therefore, it is an irony that 100% of Indonesian propellant is obtained from imports.

The main ingredients in Double Base Propellant are Nitrocellulose (NC) and Nitro Glycerin (NG), NC is produced from the nitration of cellulose, which is a long chain carbon compound (polymer). NG is produced from the nitration of glycerin, which is an alcohol that has 3 OH bonds on its three C atoms.

1.1 Celulosa

Cellulose is a glucose polymer in the form of linear chains linked by glycosidic bonds. Cellulose is the building block of cell walls in plants (Sundarraj & Ranganathan, 2018) pg89-93). It can be said that cellulose is the largest carbon element in the world and

the most abundant source of renewable polymers. Apart from plants, cellulose is also found in algae and oomycetes. Industries that use cellulose are the paper, textile, pharmaceutical, food, building materials, and explosives industries.

1.2 Cellulose Characteristic

Cellulose is insoluble in water and other organic solvents; it is due to the strong intra- and intermolecular hydrogen bonds between the individual chains. The linear chain structure causes other properties of cellulose, namely crystalline (crystal form), Chirality (same structure but different spatial arrangement and configuration), Hydrophilicity (tendency to water), and Degradability (ability to decompose). Chemically or mechanically, cellulose is not easily degraded, including in the digestive metabolism of humans and animals, so cellulose becomes a binder that is wasted with feces. Cellulose has a molecular weight that varies widely from 50,000 to 2.5 million depending on the source. The length of the cellulose molecular chain is expressed as the degree of polymerization (DP).

Cellulose, based on DP and solubility in alkali, is divided into 3 parts (Nuringtyas in (Sumada et al., 2011) pg 434) namely, α , β , and γ cellulose. Cellulose- α , long chain, insoluble in 17.5% strong alkaline solution with DP 600-1500. Cellulose β and γ are both short chains and soluble in a 17.5% strong alkaline solution with DP values between 15-90 for cellulose and less than 15 for γ .

1.3 Cellulose Source

Cellulose comes from a variety of fibrous and woody plants. The main sources are cotton, kapok, and wood. The plant parts used as a source of cellulose include coir, bark, wood, seeds, stems, leaves, and pulp, as shown in the picture below:

Apart from agricultural products, cellulose is also widely obtained from agricultural waste materials, such as bagasse (bagasse), oil palm pulp, pineapple pulp, cassava pulp (Sumada et al., 2011), and corn pulp (Asmoro et al., 2018). Bagasse in Brazil is projected to be used as a substitute for fossil fuels (Coelho Junior, LM, de Rezende JLP, Avila, 2010). Even cellulose can be extracted from the skins of various fruits, wood chip waste, and agricultural waste of staple crops (rice, wheat, beans, beets) reviewed by Sundarraj et al (Sundarraj & Ranganathan, 2018).

The Cellulose market is huge, encompassing clothing, various types of paper, building materials, electronics (diodes, LEDs), food, pharmaceuticals, and explosives. The market becomes wider if cellulose is added value, namely with nanotechnology. The uses of nano cellulose include automotive interiors and structures, spacecraft interiors and structures, superior packaging, medical and environmental sensors, air and water filtration materials, paints, 3D printing materials, electronic materials that can be recycled, and medical uses.

II. Review of Literature

2.1 Glycerine

a. Glycerine Characteristics

Physical properties of glycerin colorless to yellow liquid, odorless, sweet taste, molecular weight 92.09, boiling point 290°C, freezing point 20°C Vapor pressure 0.0025 mmHg at 50°C. Specific gravity 1.2613. pH neutral, soluble in water, alcohol, ethyl acetate, and ether, insoluble in benzene, chloroform, carbon tetrachloride, carbon disulfide,

petroleum ether, and oil. Glycerin is used in the soap, detergent, pharmaceutical, cosmetic, food, beverage, paint, resin, paper and explosives, and propellant industries.

Glycerin has the IUPAC name 1,2,3, propane triol or 1,2,3, trihydroxy propane where the H atom of the propane alkane is substituted by an OH. The distribution of the presence of glycerin conformers has been studied for a long time, including by Towey JJ.

b. Glycerine Source

Glycerin is a versatile chemical with possible applications in almost all areas of life. Glycerin was once considered a strategic raw material because one of its products, nitroglycerin, was used as an explosive in world wars. The price of glycerin decreased due to oversupply as a result of the development of the biodiesel industry and the oleochemical industry.

The potential for glycerin production can be said to be as much as vegetable oils and animal fats. Every plant that can produce oil has the potential to be extracted as a source of vegetable oil. Oil content from plant parts such as coir and pulp of palm and coconut fruit, kernel/kernel from jatropha tree, sapwood, moringa, rubber, and nyamplungan, and pulp from kesambi and malapari

The pure glycerin market is developing mainly by producing value-added products, as described by Novaol (Pagliaro et al., 2007) and by Han LJ (Ciriminna et al., 2014) regarding its prospects.

The synthetic glycerin industry was started to meet the need for glycerin for reasons of war and secrecy. It is the result of bacterial sugar fermentation (microbial sugars). (Wang et al., 2001; pg 203). The synthetic glycerin industry developed along with the discovery of synthetic processes from petroleum sources.

III. Research Method

The researcher's first reference source is documentation related to DBP raw materials, namely cellulose and glycerin. Natural materials made of cellulose and glycerin and the potential market targeted by these materials to provide an overview of the tree of cellulose and glycerin production. To enrich the data and information, several workshops were held in the form of SGD, FGD, and RTD and identified several elements of the SWOT analysis. These elements are in the form of potential DBP raw material resources, opportunities, growth potential, and important factors from a stakeholder perspective. During the SWOT analysis, all stakeholders involved were asked to provide their respective knowledge, expertise, and experience. The next step is in-depth interviews with resource persons representing various interests from government, academia, and industry to formulate a SWOT strategy and proposed priority steps. Interviews help reveal current practices, requirements, and challenges in the industrialization of DBP raw materials which will later lead to the development of the DBP industry itself as part of the independence of the Defense Industry and the realization of one of the national priority programs in the field of Defense.

IV. Result and Discussion

4.1 Supply Industry Tree

The industrial tree is a piece of knowledge-based information based on an information search that is arranged to provide an overview of the types of products that can

be made from a commodity. It can also be interpreted as the product of a commodity presented in the form of charts, pictures, or diagrams.

4.2 Cellulose Industrial Tree

As is known, cellulose is the most abundant organic chemical compound. The same is true for industries that use cellulose as their raw material. There are two main industries, namely the paper industry and the textile industry, which are traditional industries for cellulose raw materials. Other industries such as films, adhesives, and additives are industries with cellulose acetate as an intermediate raw material. With the development of nanotechnology, the cellulose market is expanding. These expansions include the automotive structure and interior industry, aerospace structures and interiors, superior packaging, sensors for medical and environmental purposes, air and water filters, and fiber-reinforced materials for buildings. The market has also penetrated electronic goods such as LEDs and the advantages of electronic equipment that can be recycled. Another benefit of cellulose that has not received attention in Indonesia is its potential as a biofuel material when converted into ethanol. Brazil is already using this biofuel and it is commercially successful.

The abundance of Cellulose sources can be divided into 4 sources, namely: wood, non-timber, marine fauna, and bacterial cellulose. Sources of wood can be further divided into hardwoods (wood trees with broad leaves) and softwoods (wood trees with pointed leaves). Well-known non-timber sources are cotton, kapok, kenaf, hemp, bamboo, and alang-alang. Then agricultural wastes that are rich in fiber are corn, rice straw, empty fruit bunches, sugarcane bagasse, and sorghum. There are two sources of animal cellulose, namely Tunicitin and animal tails. Tunicitin is an animal that lives in the sea with a mantle consisting of almost 100% pure woven cellulose. Sources of cellulose from bacteria include the activity of *Acetobacter* sp. Another potential source is algae, especially from *Cladophora*. Sources of bacteria and sources of algae are sources of non-lignocellulose cellulose (non-cellulose along with lignin).

4.3 Glycerin Industrial Tree

Glycerin is mostly produced from the breakdown of fats (triglycerides) found in living things. The primary sources of glycerin today are by-products of the oleochemical industry such as biodiesel, soaps, and fatty acids, but glycerin can also be obtained synthetically from the results of microbiological fermentation (*Saccharomyces cerevisiae*) and the reaction of NaOH and Epichlorohydrin. The volume development of glycerin as a by-product of bio-diesel manufacturing is very rapid compared to other sources. As an illustration, in 1999, Biodiesel only contributed 9% of the total glycerin manufacturing, Fatty acid contributed 47%, and in 2009, Biodiesel increased its contribution to 64% and Fatty Acid decreased to 21%. Meanwhile, from other manufacturers, such as synthetically, saponification, and a fatty alcohol, the number is also decreasing.

Meanwhile, industries that use glycerin as a raw material are health, cosmetic, polyol, paint, cosmetic, and explosives industries.

4.4 Results of Supply Availability Data Processing

DBP's main raw material data in the form of Cellulose and Glycerin are obtained from Import code numbers from trademap.org for cellulose and Bizteka for Glycerin. The raw data is in the form of tonnage exports and imports of cellulose for ten years (2011-2020) then modified with Geometric Mean Growth for the range of 2020-2024. As for glycerin, the data obtained are in the form of production, import, export, and domestic use

between 2013 to 2017. To equalize the period, it is modified with the same method to get a time of 2020 to 2024.

a. Cellulose Supply

Based on data on cellulose trade in Indonesia for 10 (ten) years using the Geometric mean growth calculation, imports of cellulose tend to decrease while exports tend to increase. When viewed from the tonnage of substances, which is dozens of times greater than exports, the Indonesian cellulose industry has a minor contribution to the demand for cellulose. With abundant sources of cellulose raw materials, Indonesia should be able to be independent in the supply of cellulose, including the raw material for the DBP Industry.

b. Glycerine Supply

Data on production, import, export, and domestic consumption of glycerin taken from Bizteka sources are then calculated using the Geometric mean growth method, although imports of glycerin will increase until 2024, exports will also increase to compensate. On the other hand, domestic consumption rose by a small percentage. It means that by ignoring the quality of glycerin, if the demand for glycerin for the DPB industry increases, theoretically, it can be achieved by only converting export volumes into domestic consumption.

c. Evaluation of Cellulose Availability

Although the availability of cellulose raw materials is very abundant, to realize it in the form of a supply chain for the propellant industry is very far from expectations. The paper and textile industry as well as industries that use cellulose materials get their raw materials from abroad by importing them. The existence of only one nitrocellulose industry has the potential to monopolize the cellulose market. It is not that the industrial community does not realize this, but the convenience of raw materials is the reason for the downstream cellulose industry players in producing finished goods whose market is clear.

d. Evaluation of Glycerin Availability

So far, more glycerin is exported than used domestically. The ratio between domestic consumption and exports is 3:1. Analysis of this phenomenon is not enough industries that make glycerin as a raw material. But on the other hand, the raw material for the propellant industry is quite guaranteed, it's just a matter of diverting glycerin for export to domestic use. The second analysis of this phenomenon is that the glycerin produced is not of good quality enough to be used as a propellant raw material. In this case, the purification industry and improving the quality of glycerin are needed.

The government in protecting the Defense Industry has played a significant role. Several policies in the form of monetary and fiscal policies have been issued, including reducing requirements in licensing, providing tax incentives, and so on. However, this policy must be supported by human development as a technology management agent, so that Indonesia's development in all fields can be sustainable.

3.5 SWOT Analysis

After understanding the characteristics of the supply industry tree and the numbers that talk about the data processing of supply material availability, it is necessary to formulate a SWOT analysis to find strategies for exploiting strengths, improving weaknesses, exploring opportunities, and fighting challenges. Three general steps are also carried out, namely, the Identification of SWOT elements, Strategy Formulation, and

Strategy Determination (discussed). Researchers get all SWOT elements from the results of discussions and in-depth interviews with informants by obtaining confirmation or compromise, if there are sharp differences of opinion between sources.

a. Identification of SWOT Elements.

The first step in a SWOT analysis is the identification of policy elements. Stock evaluations are typically used for existing and emerging industries that are used in this paper to evaluate propellant industry development plans (in this case DBPs) that have been announced by stakeholders for a long time. The plan is continuously monitored by issuing various policies. In terms of strength, the researcher believes that Indonesia is rich in natural resources and has good technological capacity. In terms of weaknesses, it must be acknowledged that commodity prices fluctuate and the fact that Indonesia is happy to import finished goods and export raw goods. One of the opportunities that can be exploited is the policy to use domestic production, while the challenges are price wars with similar producers that are not healthy, in addition to pressure from Indonesia to protect the environment and the existence of strict protective policies which are not following the spirit of the inclusive Sustainable Development Goal.

b. Strategy Formulation

After getting the SWOT formula, the next step is to exploit the advantages of strengths and opportunities and deal with weaknesses and threats (war gaming), so that big profits are obtained. So that if the use of internal variables for external conditions is described, there are four parts of the strategy, namely first, using strength in opportunity (S-O). For example, the abundance of uncooked substances is utilized in possibilities that prioritize home production, the method is to construct a DBP enterprise devoted to raw substances usage from Indonesia. Second, using Strength in Threat (S-T), for example in environmental issues, Indonesia builds an industry that is efficient in energy use. Third, addressing weaknesses in opportunities (W-O), for example by making a clear road map strategy, Indonesia will avoid the tendency to import finished materials and export raw materials, and fourth is dealing with weaknesses in threats (W-T). For example, the development of raw material reserves will reduce fluctuating price pressures.

3.6 Analysis and Discussion

a. Strategy Determination

Determining the right strategy is the last step of the SWOT analysis, but this paper is separate because it involves discussion. During the interview, the researcher asked the informants to rank the SWOT strategies according to their educational background and experience. The sequence of strategies is then compiled and entered into a table so that the favorite strategy can be determined according to six sources.

3.7 Discussion

For the supply side, the most important thing is the implementation of the propellant industry roadmap mapping. Of course, a comprehensive roadmap that at least contains the achievement criteria with their respective schedules. This roadmap as well as other roadmaps is packaged concisely, provides one interpretation, is measurable and achievable, and is flexible in the face of change. In the preparation of this comprehensive roadmap, various stakeholders are involved so that it is accommodated in the final product. An element that should not be left behind in the preparation of this roadmap is the budget to be

allocated. Another crucial element is leadership and coordination. Where the firmness in carrying out activities that are still guided by the agreement that has been made.

The propellant enterprise calls for a delivery chain device that guarantees the provision of excessive raw materials. To shape a delivery chain, it's miles essential to grasp strategies for extracting cellulose and glycerin from uncooked materials. Research is needed on the potential and processes of each of these raw materials. Between glycerin and cellulose, the interviewees believed that the Cellulose Industry and the Nitro Cellulose Industry, as intermediate industries, should be a priority. Because in reality with so many product utilities, the cellulose industry is not developing in Indonesia, still relying on imports from other countries. The cellulose needed for the DBP industry is a type of long chain, so the emphasis should be on plants or microorganisms of this kind.

An established market for both, cellulose and glycerin needs to be addressed by establishing a new supply chain system that involves new types of raw materials. So hopefully, there will be no struggle for raw materials. However, achieving this requires research efforts on materials and manufacturing processes.

3.8 Supply Side Records and Evaluation

Evaluation for the supply side is the establishment and development of communities or community associations related to the supply of raw materials for the DBP industry. Indonesia is still spoiled with the abundance of products needed from imports. It has not been thought of to process raw materials in their own country to be used for downstream industries. Indeed, achieving this requires technology and capital that is not small. It may be true that the analysis from several sources stated that Indonesia needs a critical moment (embargo) so that it realizes the importance of the meaning of independence, as happened in Iran and Turkey as an example.

Raw materials from Indonesia are imported abroad and returned to Indonesia as industrial raw materials in Indonesia, including the DBP Industry. So that the increase in value occurs in other countries. Economically and politically is detrimental and makes Indonesia not independent. Immense capital is required to make it happen, as well as time. Therefore, it is necessary to commit to realizing this independence by mobilizing the resources of this country. Of course, there will be uncomfortable consequences with this decision, such as the consequences of budget, technology, and also human resource development. It can be called an investment, and this also confirms the statement from the Minister of Defense that the procurement of defense equipment is not an expenditure, but an investment. Cellulose and glycerin are not defense equipment, but their product, namely DBP, is one of the ingredients of the primary weaponry system and is included in the priority program in the field of defense.

In building the propellant industry, apart from the primary raw materials (cellulose and glycerin), no less significant are additives, which can provide better performance for munitions. For this reason, it is necessary to conduct studies and research as well as the implementation of research on this additive technology. Of course, by paying attention to the sequence of development implementation starting from the draft, literature study to strengthen the theory, then lab scale work and transition to the industrial stage (scale-up), and finally to be industrialized or commercialized.

V. Conclusion

The propellant industry must be established in Indonesia, because of its urgency to state sovereignty, especially in the defense sector. The Defense System always prioritizes the development and development of the defense industry which has its distinctive characteristics, namely high technology, excellent quality, and a narrow market. In evaluating this propellant industry plan, in the previous chapter each evaluation has been carried out so that the compilation is as follows:

- a. The independence of the Double Base Propellant industry and its supporting industries in Indonesia will be supported from the supply side even though it is in the planning stage because Indonesia is blessed with abundant natural resources. However, the sequence of steps and the formulation of achievement must be carefully considered.
- b. Develop a roadmap that can be guided completely by achievement criteria and a timeline for achievement accompanied by consistent budget support
- c. The Propellant Industry supply chain management system needs to be built and fostered as a guarantor of the availability of quality raw materials.
- d. The orientation of the priority sequence for the development of the Propellant Industry system, both main ingredients and additives, supported by accurate research results.

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