International Journal Of Humanities Education And Social Sciences ***(IJHESS)*** *E-ISSN:* **2808-1765**
Volume 3, Number 4, February 2024, *Page. 2023 – 2029*
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Diagnostic Analysis Of Potential Risks And Security Systems In Rocket Development As A Supporter Of The Defense Environment Ecosystem

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Abstract

State defense is essentially all universal defense efforts which means involving all citizens, territories, and other national resources, as well as being prepared early by the government and held in a total, integrated, directed, and continuous manner to uphold state sovereignty, territorial integrity and the safety of the entire nation from all threats both from outside and from within. This research aims to diagnostically analyze the potential risks and safety systems in rocket development as a benchmarking and basic foothold in the growth of the weapons technology ecosystem. This research uses a qualitative approach method with a literature study approach. The results obtained are in the form of various potential risks which can provide failures and losses in rocket development. The safety system that is possible to implement by prioritizing the suitability found in Indonesian rocket development, is to review and ensure the stages of preparation, integration and testing (or similar) in rocket development.

Keywords: Defense, Risk, Safety, Rockets.

INTRODUCTION

The Indonesian National Army as a means of national defense, based on Law of the Republic of Indonesia Number 34 of 2004 concerning the Indonesian National Army, n.d. article 7 paragraph 1 states that the Indonesian National Army is tasked with implementing national defense policies to uphold state sovereignty, maintain territorial integrity and protect the safety of the nation, carry out military operations for war and military operations other than war, and actively participate in regional and international peacekeeping tasks. In carrying out its duties, the Indonesian National Army is equipped with the understanding that the Indonesian National Army has an identity, namely as a People's Army, a Fighting Army, a National Army, and a Professional Army.

The measure that makes soldiers called professional in carrying out their duties is well trained, educated and equipped. Being an educated and trained soldier can be produced through the implementation of education taken at the Education Institute according to the branch and specialization of each soldier, and can be obtained through education carried out in the unit. In addition to being educated and trained, a soldier must also be well equipped. This equipping is in terms of individual needs and group needs. In terms of group needs required in carrying out the task of maintaining national defense, what is very important and must be considered is the provision of a weapon system that is in accordance with the main task of each unit. Of course, this weapon system must follow technological developments and also cannot be separated from world political developments.

Based on Ganda Samosir's research in 2012 (Samosir, 2012) about the RX.320 rocket propulsion, it has a high flash point, but is essential and risky given the speed of the rocket's combustion process, which reaches 7mm/s. The propellant flash point in the rocket body is assisted by instruments to conduct electricity to the rocket ignition, which then transfers heat to the propellant and rocket engine. To minimize unwanted risks, the potential risks that arise during the operational process should not be underestimated, but also become the main focus in the operational, integration stage up to the rocket testing stage.

Currently, various countries in the world continue to compete to display the defense power of their country in order to create a deterrence effect for other countries. The strength of the country's defense, in addition to the composition of the strength of military personnel, which is the strength of the country's defense is the strength of the main weaponry system commonly referred to as Alutsista. In fulfilling its Alutsista, Indonesia has begun to make its own several weapons systems and Alutsista such as ballistic missiles, rockets, rantis, Assault Rifles, Panser Anoa which are produced domestically by a consortium of defense industries.

However, it must also be realized that there are still many TNI defense equipment procured through foreign purchases. Although there are still rules listed in Law Number 16 of 2012 concerning the Defense Industry, n.d. about the Defense Industry that every procurement of defense equipment must involve the defense industry. This is related to the existence of Trade Imbalance, Local Content, and Offset (IDKLO). If Indonesia wants to optimize its national defense forces, then what must be done is to realize the independence of the defense industry. This has begun to be implemented by the Indonesian government through technological developments in the defense sector as mastery of defense technology.

Mastery of defense technology is a must for a country to maintain its territorial sovereignty. As a large country, Indonesia needs capable defense technology. A strong national defense affects the ideological, political, economic, social and cultural aspects of Indonesia. (BPPI, 2015). Threats both from within and outside the country require a strong defense force, especially the Indonesian National Army (TNI) as the spearhead of the state defense apparatus, requiring quality and quantity of personnel and reliable defense equipment. As the main guardian of the defense and security of the Indonesian territory, the TNI needs defense equipment that can withstand all threats on land, sea and air.

In addition, it is necessary to master defense equipment technology so that Indonesia can make defense equipment independently so as to avoid defense equipment embargoes from other countries. However, mastering advanced defense equipment technology requires high costs and a long time (Anwar, 2015). So the Indonesian government through the Defense Industry Policy Committee (KKIP) made 10 priority programs for the development of defense equipment in the defense industry road map 2023-2045, including:

1. Fighter Jet Aircraft Development
2. Submarine Development
3. Amphibious Medium Tank & APC Development
4. Radar Development
5. Missile Development
6. Rocket Development
7. Propellant Development
8. Unmanned Aircraft Development (PTTA)
9. Development of military satellites
10. Development of underwater sensing system

An example of the risk is that in 2010 at least 200 people died as a result of rocket explosions during the rocket testing, launch preparation and operational processes. Some cases also involve launches where spacecraft fail to orbit and fall back to Earth. Some cases are relatively recent, notably China Great Wall Industry Corporation, which managed the launch of a Long March-3B/G2 (Chang Zheng-3B/G2) rocket carrying the Nusantara 2 satellite payload, which failed to launch. Although standards are available for operational reference right up to the launch process stage, these events show that the process of testing, preparation, and integration operational activities require safety controls that require conformity in each country (Damayanti, 2020)

Based on the background study and preliminary analysis in the field conducted by researchers, there is a need for efforts in realizing the mastery of rocket technology which is a technology that is strategic enough to be controlled nationally in a country. Related to this, institution X has a Rocket Technology Center (Pustekroket) with the main task of carrying out research and development activities for rocket technology and its utilization. In carrying out its duties, one of its functions is to organize research, development and engineering of propellant technology (LAPAN P. , Tugas Pokok, 2014).

In order to master rocket technology which as a whole is a fairly strategic technology, and increase the maturity level of the research industry, especially Institution X, it is also necessary to have a rocket operational system that is safe for humans to work on and can save a rocket from human error. This refers to the objectives of this research related to the diagnostic analysis of potential risks and safety systems in rocket development as a benchmarking and basic footing in the growth of the weapons technology ecosystem.

RESEARCH METHODS

In writing this article, the author used a qualitative research method with a literature study approach. According to (Creswell. Jhon W, 2018), literature study is a research approach based on non-numerical data in the form of text and images, where the material is distilled to provide an interpretation of the literature review. Research is conducted using literature sources such as journals, books, articles, research reports, and scientific articles that contain valid and authoritative sources. The literature used in this study comes from various data sources and references which in this study will focus on previous research journals related to diagnostic analysis of potential risks and safety systems in rocket development as benchmarking and basic footing in the growth of the weapons technology ecosystem.

The data used is secondary data supported by similar research. Testing is carried out by integrating perspectives from various empirical findings so that this writing is stronger because of the support of various scientific perspectives, by describing previous research to get an overview and approach used to achieve research objectives and to prove research questions or hypotheses built (Snyder, 2019). A literature review can be a simple summary of sources, but it has a pattern of organization and combines summary and synthesis. In the literature review method, researchers are required to have a variety of skills, such as creating a topic definition for exploration, obtaining appropriate literature, analyzing, and synthesizing data in written form (Ramdhani et al., n.d.). The description and review of the literature review are expected to be a comprehensive study in the window of thinking horizons to get an overview of the diagnostic analysis of potential risks and safety systems in rocket development as a benchmarking and basic footing in the growth of the weapons technology ecosystem.

RESULT AND DISCUSSION

In accordance with the title proclaimed in this research and based on the conditions, situations and potentials faced related to potential risks and safety systems in rocket development as benchmarking and a basic foothold in the growth of the weapons technology ecosystem, has encouraged researchers to conduct research in the form of a diagnostic analysis review.

Researchers attempted to review and obtain 10 literatures that support research activities. The literature is described in the discussion described in this study.

The first research was conducted by Chongwen Jiang in 2019 (Jiang et al., 2019) entitled A review of impinging jets during rocket launching. This research uses a methodology in the form of a quantitative approach with an observational research concept. The results obtained are an overview of the progress and perspectives of jet impact research for rocket launching. It starts with a summary of the results obtained for normal and inclined jets impacting a flat plate, then the interactive mechanism between the impacting jet and the launch platform or deflector system, along with relevant factors affecting the flow field and noise. The potential risk found in this study is that the impact of engine exhaust causes large aerothermodynamic and acoustic loads on the launch structure and rocket, and these overloads can potentially pose a risk to the rocket launch. Therefore, it is important to predict and reduce these risk loads.

The second study was conducted by Paul Grald in 2018 (Gradl et al., 2018) entitled Additive Manufacturing of Liquid Rocket Engine Combustion Devices: A Summary of Process Developments and Hot-Fire Testing Results. This research uses an identification and observation approach methodology in an industrial environment. The results obtained in this study successfully revealed that there are hardware combustion components that have potential risks but are still used in development. Combustion devices include thrust chamber injectors, injector components such as faceplates, regeneratively cooled combustion chambers, regeneratively cooled nozzles, gas generators and improved preburner and spark igniter hardware. Ongoing and future developments for combustion devices also include the design of components sized for boost class engines.

The third research was conducted by Nugroho in 2022 (Nugroho et al., 2022) which is entitled Risk Analysis of Operation Igniter Technology System for Rocket Motor X. This research uses a qualitative methodology approach and uses the HIRADC concept in risk assessment on rocket launches. The results of this study reveal that there are several activity processes carried out by expert operators in rocket launching. The results of the risk assessment in the X rocket motor testing process on the application of the ignition system, there are 10 risks in activities consisting of 8 activities that have a "low" risk level, while the other 2 have a "High" risk level. Caused by probability 1 and severity 4 which can result in the explosion of the device and the death of the user. The next scope of assessment is instrument risk assessment. Based on the research conducted, the results obtained from the risk assessment are 13 risks of instrument failure consisting of 9 risks with a risk value of "low". While 2 risks with a risk value of "moderate" are short circuits on cables and unburned casings that can cause serious injury. As for the other 2 sectors that have a high risk, there is a risk of not being grounded which can result in static electricity not entering the ground, early ignition during installation and explosions that can cause death.

The fourth research was conducted by Cahyono in 2021 (Mahendro Cahyono et al., 2021) entitled Requirements Analysis and Technology Readiness Level of R-Han 122B Ballistic Rocket Weapon System towards Indonesian Defense. This research uses a qualitative methodological approach through a descriptive analysis approach. The findings of this study reveal that there are user requirement findings: Rocket ammunition must be safe for personnel both technically and tactically. The results of the research in the form of R-Han 122 B requirements from the development have not been in accordance with what the Navy Marine Corps wants. The R-Han 122 B propellant uses HTPB composites, causing thick smoke. While the ballistic rocket used by the Navy Marine Corps (RM 70 Grad) uses double base solid propellant so that the smoke generated is thin. On the ability of precision (flight stability), the launch of the R-Han 122 B has not been grouped (grouping) The development of the R-Han 122 B has not followed the system engineering stage because there is no document requirement in the requirements section of the user, and the development stages have not been run like the stages in system engineering. The level of technology readiness (TKT) of the R-Han 122 B rocket is at level 7.

The fifth research was conducted by Damayanti in 2020 (Damayanti, 2020) entitled Juridical Review of Spacecraft Launch Safety in the Draft Government Regulation on the Mastery of Space Technology. This research uses a Qualitative methodological approach and a normative juridical approach. The findings of this study reveal that safety per launch stage, namely pre-launch, during launch and after launch including if there is a failure in launch (failed and critical phase of launch); licensing and responsibility. The need for the preparation of a separate Government Regulation on safety or Institutional Regulations that apply nationally.

The sixth research was conducted by Barmin in 2017 (Barmin et al., 2018) entitled Problems of ground safety supporting at launch of space vehicles with manned spacecraft. This research uses an Observative qualitative methodology approach. The findings of this study reveal that safety factors are provided through all phases of space flight preparation and transportation including: pre-launch phase that functions during launch preparation; Rocket injection phase; Rocket flight after its separation from the ground and also in other cases. The required level of safety is obtained by creating special equipment in the form of signage in ensuring emergency evacuation of the crew and assisting personnel in critical non-nominal situations.

The seventh study was conducted by Galeev A G in 2017 (Galeev, 2017) entitled Review of engineering solutions applicable in tests of liquid rocket engines and propulsion systems employing hydrogen as a fuel and relevant safety assurance aspects. This research utilizes Qualitative methodology approach of review & observation. The findings of this study reveal that techniques and equipment intended to ensure the safety of ground tests of rocket engines and power plants involving the use of effective diagnostic systems and emergency protection systems have been considered.

The eighth research was conducted by Velthuysen in 2018 (Velthuysen et al., 2018) entitled Safety Aspects of Nitrous Oxide Use in Hybrid Rocket Motor Design and Testing. This research utilizes a Qualitative review & observation methodology approach. The findings of this research revealed that This paper outlines two recent examples of uncontrolled nitrogen oxide decomposition in hybrid rocket systems at the University of KwaZulu-Natal (UKZN) in South Africa and at the University of Alabama in Huntsville (UAH). This paper describes the origins and outcomes of such incidents and explores ways in which such incidents can be avoided. In addition, hybrid rocket motor design recommendations are proposed to reduce operational risk. 1) Risk of temperature difference, 2) Oxygen cleanliness to combustion, 3) Maintaining head pressure in tanks.

The ninth study was conducted by Artamonov in 2017 (Artamonov et al., 2017) entitled FIRE SAFETY OF GROUND-BASED SPACE FACILITIES ON THE SPACEPORT "VOSTOCHNY". This research utilized a Qualitative methodology approach of review & observation. The findings of the research revealed that 1) the lack of water screen systems providing protection of service personnel and equipment elements of the spaceport object against the action of dangerous factors of fire, 2) the absence of a fulfilled scheme of evacuation of service personnel from the emergency zone of the spaceport object by means of water screens, individual survival equipment and so on and so forth, 3) The absence of dangerous zone markings of the location of remotely operated rockets and the possibility of explosions and fires.

The tenth study was conducted by Pou et el in 2019 (Pou et al., n.d.) entitled Design of an On-board Flight Safety System for Space Microlaunch Vehicles. This research utilizes an observational Qualitative methodology approach. The findings of this study reveal that this research first reduces the pre-flight phase dedicated to mission configuration, equipment preparation, and safety operator training; and second, provides autonomous real-time operation devoted to the processing of tracking means and safety decision making. The objective of this study was to validate the performance (reliability, accuracy, and availability) of the safety module served by a lightweight and cost-effective navigation system in the critical operational scenarios identified for its rocket concept. The results of this study contribute to the definition circle of airborne systems (alignment maneuvers, release systems, launcher aerodynamics) and provide an awareness of real-time safety operational scenarios at a time when the rocket is still on the ground.

Based on strategy theory, it is known that the ultimate goal of the fulfillment of defense equipment is the independence of defense equipment procurement. Where Indonesia is able to meet the needs of defense equipment through research and the domestic defense industry, without imports. As for (means) by using qualified supporting facilities and infrastructure, and (ways) by making policies and improving facilities and infrastructure and safety systems in the domestic defense industry.

This needs to be done because if we are too dependent on importing defense equipment from abroad, then the movement of Indonesian defense equipment will be easily known by other countries. In addition, other countries will easily regulate the movement of Indonesian defense equipment with their foreign import policies, which causes Indonesia's defense forces to be threatened.

Through diagnostic analysis carried out in looking at the current situation related to potential risks and safety systems in rocket development, it will become an underlying assumption and basic footing in growing the weapons technology ecosystem. Stakeholders, experts and the government can find out the potential risks experienced by other countries in rocket development, as well as safety systems that are possible to implement by prioritizing the suitability of Indonesian rocket development.

CONCLUSION

As a basic footing in growing a better developed weapons technology ecosystem, the conclusions of this article related to potential risks and safety systems illustrate that stakeholders, experts and the government must be careful in developing rockets. It is characterized by potential risks that can provide failures and losses in rocket development. The safety system that is possible to be implemented by prioritizing the suitability of Indonesian rocket development is to review and ensure the preparation, integration and testing (or similar) stages in rocket development.

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