Identification of Launcher Vehicle Prototype Development of Rocket "X" 122 Caliber

Zaenal Asiqin[1], Y H Yogaswara[2], and Nur Rachman Supadmana[3]

[1,2,3]Weaponry Technology, Faculty of Defense Technology, Defense University, Bogor, Indonesia

Coresponding Author's Email: [1]zaenalasiqin82@gmail.com

Abstract— The development of a prototype rocket launcher vehicle 122 calliber has begun in 2017-2019, by being carried out in stages and separately. So, it takes an effort in the development review every year, as well as an analysis of the suitability of the design requirements on the resulting prototype. The research method used is a qualitative method with a case study approach. In this study, the results of the review showed that the prototype of the X rocket launcher vehicle was in accordance with the required requirements. This refers to the 4 (four) design requirements, namely, an appropriate support and slide delivery system, an appropriate turret system, an appropriate transporter system and an easy and safe operating system.

Keywords— Prototype, rocket launcher vehicle, design requirement.

1. INTRODUCTION

Rocket is a technology of the Main Weapon System Tool (Alutsista) which has strategic value for the development of defense industry and technology in Indonesia. Currently, the development of the 122-caliber X rocket has been successfully carried out in Indonesia, and for this reason, further development is needed in an effort to empower effective defense equipment. To realize this, a rocket launcher system vehicle that is compatible with the X rocket is needed.

In 2017-2019 the development of a prototype X rocket launcher vehicle has been carried out. In 2017 the manufacture of a 122 caliber X rocket launcher vehicle prototype has reached the stage of making a prototype control system that still uses manual electrical control with output in the form of hydraulic pressure on the accuator.

In 2018 the implementation of the prototype development program for the X rocket launcher vehicle has reached the automation stage I, which includes the stator pedestal, sliding system, swifle connection system, pipes and hose. In 2019, the focus of development is on upgrading the weapon system with the addition of a launcher tube with a total of 40 tubes, and a ballistic software automation system.

The development of the prototype of the X caliber 122 rocket launcher vehicle was carried out by creating a consortium between research institutions and the defense industry. This will have an impact on the independence and development of defense technology in the long term. The development carried out in 2017-2019 is carried out separately and continuously until it produces a product.

This requires a conformity review to find out how big the relationship is at each stage, to produce the desired prototype. Based on the background of the problem, an effort is needed in conducting a review related to the development of the prototype X caliber 122 rocket launcher vehicle that is being described in this study. This research aims to effort to provide a review of the prototype development of the X rocket launcher vehicle, and analysis of the suitability of the design requirements with the resulting prototype.

2. METHODOLOGY

The 122-caliber X rocket is the result of the grand design of research institutions and related stakeholders to realize independence and fulfillment of defense technology. In this case, to make an effective defense system, the X caliber 122 rocket requires a vehicle launch system that is suitable and able to meet user needs.

The research was conducted using a qualitative method approach, which, according to Sugiyono (2018), qualitative research researches that aims to find, analyze and manage direct events in the field by understanding social interactions with interviews. Qualitative research methods are considered suitable for this research, because researchers are trying to find, analyze and manage direct events that occur in the field, especially related to the development of the X caliber 122 rocket launcher vehicle.

Research design as a strategy to achieve research objectives that have been previously defined and acts as a guide or guide for researchers throughout the research process. One of the research designs that can be used in qualitative research and is suitable for this research is a qualitative research method with a case study approach.

This research uses a qualitative method with a case study approach to the development of the X caliber 122 rocket launcher.

Yin (2019), explains that qualitative research with a case study approach is a research design that requires researchers to develop an in-depth analysis of a case, which can be a program, event, activity, process, or one or more individuals. Furthermore, Poerwandari (2007) describes that the case in this case can be a decision, policy, process, or a certain special event.

3. RESULT AND DISCUSSION

3.1. Stage 1 development

Building and developing the defense industry is realistic vision for Indonesia in responding to the dynamic challenges of regional and international strategic developments. Making the prototype of the X rocket launcher vehicle produces appropriate technology, so that the resulting technology can be expected to be easily applied in testing and product realization, both in series and mass production.

In the development carried out in stage 1, research was conducted with a focus on initial development in the form of analyzing user operational requirements, and making design reviews that were in accordance with operational requirements.

The operational requirements of users that become a reference in making prototypes are as follows:

i. **Reliability:** Have multi-caliber capabilities and can shoot and move quickly.
ii. **Adaptability:** Has individual propulsion capability, high cruising range, and can adapt to the operating field.
iii. **Interoperability:** Have the ability to integrate command management systems with control systems.
iv. **Substainability:** Vehicles are expected to have an active/passive protection system and a continuous supply of spare parts.
v. **Ability:** Having navigation equipment on board, implementing a modular system to facilitate transportation, self-loading, and unloading, and is expected to have the ability to protect the crew of the rocket launcher.

To meet the operational requirements set by the user, in stage 1 the prototype of the X rocket launcher vehicle has a design reviewed by the author, as follows:

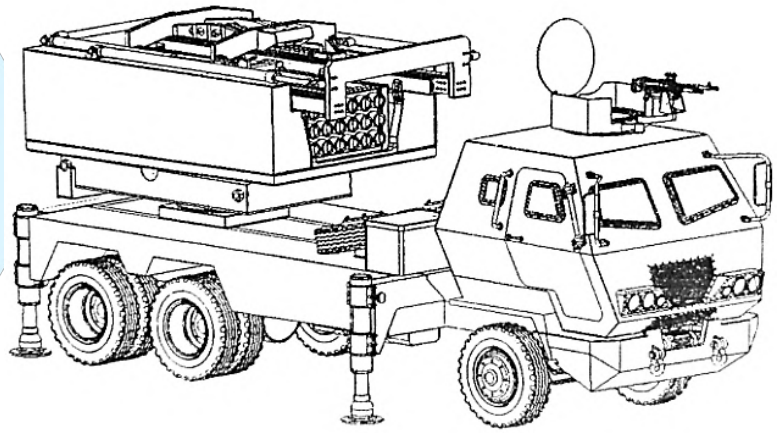

Figure 3.1: *X rocket launcher vehicle design*
Source: *Author, 2021*

1. Main bearing

The ability of the main bearing serves to maintain the estrangement of the shaft so that when the unit starts to work, the rocket components inside do not move and failure occurs. Thus, the application of the main bearing is expected to provide a smooth hydraulic movement effect.

2. Slewing bearing

The ability of the slewing bearing is expected to become the runway for the rocket launcher module. The slewing bearing has two parts, namely a fixed part that is locked and integrated with the chassis, and a rotating part. Slewing bearing is an operational requirement due to avoiding failure in the form of backlash which can affect shooting accuracy.

3. Vertical and horizontal motion system (Altitute and azimuth motion)

Vertical firing drive system, designed with a servo motor and linear actuator drive. Servo motors are widely used to drive turret tanks because of their precise movement. The servo motor component has two

modules, namely the motor and the drive (inverter). Linear actuators are used to obtain precise motion to less than 0.1 mm.

This actuator uses an electromechanical type (Power Screw) which is driven by a servo motor so that from the vertical motion design, a high lifting power of up to 10 tons can be obtained.

4. Plummer block

The plummer block function is designed to install the bearing in a secure position, thus allowing the bearing to be static or stationary. The plummer block also functions in aligning the bearings.

Plummer block is designed with cast iron material that has high strength as a standard. Plummer block features a lubricating tube component and has the advantage of being able to accept matrix and imperial shaped shaft sizes.

5. Fire control system

This system is designed by integrating servo control and movement, position sensors and firing software. Fire control is designed to be performed from inside and outside the cab, with a modular system. The fire control process from inside the cabin is currently not recommended because the level of risk involved in the process is very high, but the firing compartment inside the cabin is designed to be provided to show the ideal conditions of the rocket launcher. Fire control outside the cabin can be done with a maximum distance of 60 meters.

3.2. Stage 2 developments

Prototype of the X rocket launcher vehicle in phase 2, focusing on the design and analysis of software and hardware. The software designed is depicted in Figure 3.2, and the hardware includes the sensor position described in Figure 3.3. including

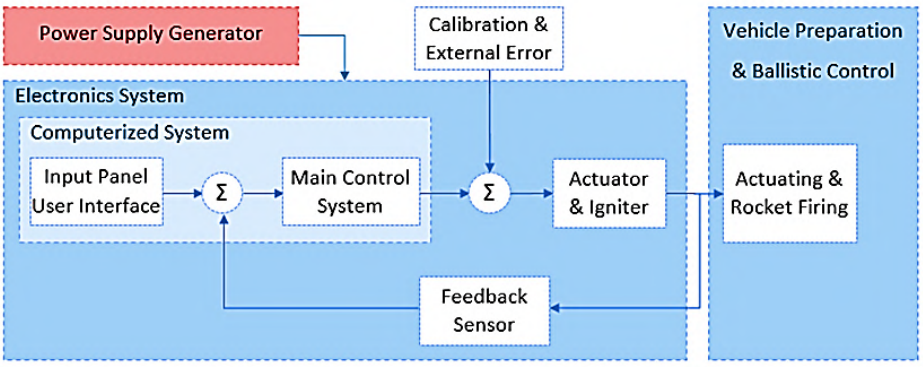

***Figure 3.2**: Sensor and actuator control system algorithm*
***Source:** Internal development report, 2018.*

Based on Figure 3.2 above, it is illustrated that the sensor and actuator control algorithm system have power supplied by the generator power supply. The computerized system is based on the user interface (UI Panel) input panel and the main control system. The main control system works to be able to give orders to the actuator and igniter to be able to work according to the command. The feedback sensor works to detect the color of an object; the hue parameter of an object color is used. Then do the conversion of the color system from RGB values to HSV (hue-saturation-value).

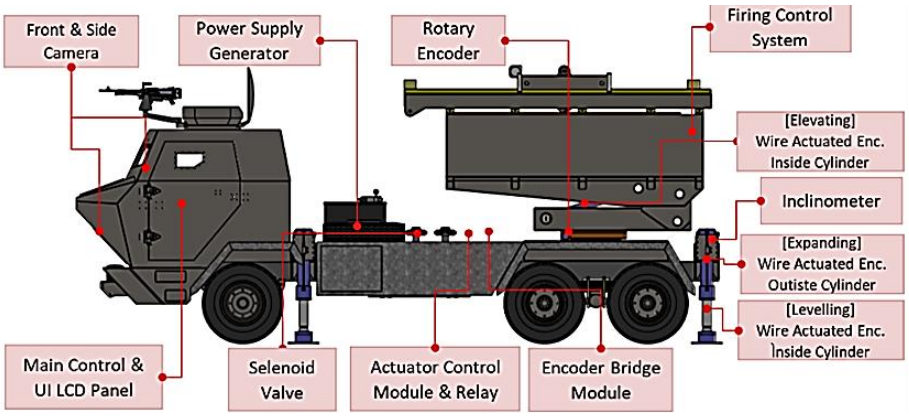

***Figure 3.3:** Position Sensor on X. Rocket Launch Vehicle*
***Source:** Internal development report, 2018*

The control system automation integrates several features, namely, user panels, actuators and feedback, firing systems and ballistic formulation. It is hoped that by implementing this software design, the control system with electric buttons can be changed to an automatic control system that is integrated with personal authentication features.

3.3. Stage 3 development

The focus of this program is to improve the mechanical design and upgrade the 40 tube launcher which can work automatically and can be tested using the R-Han 122B rocket.

In 2019 stage 3, a weapon system upgrade was developed with the addition of 22 launcher tubes, bringing the total launcher tube to 40 launcher units.

In addition, an upgrade of the automation system was carried out by integrating ballistic calculator software connected to Programable logic control (PLC) as the main controller (Main control) with a feedback sensor installed.

3.4. Launch Vehicle Test

The dynamic test was carried out to validate the prototype design of the X rocket launcher vehicle, by observing the vehicle performance data when firing the X rocket. The results of the review carried out in the testing activities, namely:

3.4.1. Endurance test

The test was carried out by traveling a distance of 305 Km by testing the ability in the form of incline power, turning power, acceleration and deceleration, which got good results.

Vehicle safety checks were carried out to test the braking system by looking at the instrument and combat lights, with the result that the entire system was functioning properly.

The testing implementation of the vehicle stabilization test is carried out with the following materials:

a. Under/Over steering
b. Drift vehicles
c. Axle tramp
d. Safe speed on the freeway up to 90 km/h

The results obtained from stability testing within the scope of endurance got good results and were within normal limits, and no malfunction was found for the entire system in the X rocket launcher vehicle prototype.

3.4.2. System test

System testing is in the form of internal features possessed by the X rocket launcher vehicle prototype, while the results of the reviews carried out in the test are as follows:

a. Loading test

The loading test on 40 barrel tubes from the X rocket launcher vehicle was divided into 2 stages, namely the first stage with 18 tubes and the second stage with 22 tubes. The results obtained from the first stage obtained an evaluation of the improvement in the mechanical sector in the barrel tube. The results obtained from the second stage obtained evaluation results in the form of normal conditions and running well.

b. Azimuth test

The results obtained from the azimuth test are in the form of an X rocket launcher system that can be moved azimuthally up to 360 degrees to the left and right.

c. Elevation test

The results obtained from the elevation test, in the form of the X rocket launcher system that can run well, include movement in elevation up to an angle of 55 degrees.

d. Ballistic calculator test

Implementation of the test in the form of finding the angle of shooting against the target from the top of the vehicle. The results were obtained in the form of a device that can sense objects that can be detected automatically and fall into the good category.

e. Firing simulation test

The implementation of the test is in the form of using a squib which functions as a lighter for the initial process of firing a rocket. The results obtained are the device can run well, and there are no malfunctions in the rocket launch.

3.4.3. Rocket test firing

a. First test rocket fire. Single caliber X 122 rocket firing using a WIFI network with a tablet computer and an azimuth angle of 260 degrees, and an elevation of 30 degrees. The results were obtained in the form of an estimate of the fall of the rocket at 20 Km from the firing.

b. Test firing of the second rocket. The firing of a 122 caliber X rocket with an azimuth angle of 260 degrees and an elevation angle of 30 degrees. The process is

carried out using a firing system which is divided into 3, namely:

- Shooting using a single system method with mission computer equipment in the cabin got good results and ran smoothly
- Shooting using a single system by pressing the push button on the cabin, got good results and ran smoothly.
- Shooting using a ripple system with WIFI network equipment on a tablet computer, got good results and ran smoothly.

3.5. Analysis of the Suitability of the design requirements with the prototype

In making an effective defense system, the X 122 caliber rocket requires a launcher system that is suitable and able to meet field requirements. The design of the rocket launcher system vehicle x needs to consider a number of criteria, including

a. It has a support system and a glide conductor that is in accordance with the caliber of the rocket being launched, so that the rocket can glide smoothly and stably.
b. Has a turret system that allows the launch of the rocket at various angles of elevation and azimuth according to the needs in the field.
c. Equipped with a transporter system that can facilitate the movement of the launcher system according to operational needs.
d. Can be operated easily and safely in various conditions according to field needs.

The results of the prototype are designed, reviewed and obtained results that can meet the required requirements. The results are depicted in table 3.1, as follows:

Table 3.1: *The results of the conformity of requirements with the prototype.*

No.	Design requirements	Description	X rocket launch vehicle prototype		
			Suitability		Description
			Suitable	Unsuitable	
1	Sliding support and conveying system	It has a support system and a glide conductor that is in accordance with the caliber of the rocket being launched, so that the rocket can glide smoothly and stably.	★		Has a slewing bearing support system with launcher assembly.
2	Turret system	Allows rocket launch at various elevation angles and azimuths according to field requirements	★		The turret assembly was used in the prototype X rocket launch vehicle.
3	Transporter system	Make it easy to move the launcher system according to operational needs.	★		The transporter system is applied in the operation of the prototype X rocket launcher vehicle. The vehicle has been tested by endurance testing carried out by traveling a distance of 305 Km
4	Easy and safe	Can be operated easily and safely in various conditions according to field needs	★		Fire control that can be done from inside and outside the cab, with a modular system that makes it easy for the user.

Source: *Author, 2021*

The descriptions that are attempted are described as follows:

a. The prototype of the X caliber 122 rocket launcher vehicle is designed to have a slewing bearing to support system with a launcher assembly. The launcher assembly has the advantage that it can accommodate up to 40 barrel tubes from the rocket launcher. This has been tested in loading tests which

get evaluation results in the form of normal conditions and running well.

b. The turret system is used in the prototype of the X rocket launcher vehicle. The turret assembly is used in the prototype of the X rocket launcher vehicle. The test results show that the azimuth test in the form of the X rocket launcher system can be moved azimuthally up to 360 degrees to the left and right, and the elevation test is in the form of the X rocket launcher system can run well covering the movement of the elevation to an angle of 55 degrees.

c. The transporter system is implemented in the operation of the prototype X rocket launcher vehicle. The vehicle has been tested by endurance testing carried out by traveling a distance of 305 Km, with ability tests in the form of incline, turning power, acceleration and deceleration, which got good results. Vehicle safety checks were carried out to test the braking system by looking at the instrument and combat lights, with the result that the entire system was functioning properly.

d. Within the design requirements, the launcher control system can be used easily and safely in all conditions. The prototype rocket launch vehicle is also designed with fire control that can be carried out from inside and outside the cabin, with a modular system that makes it easy for the user. The fire control process from inside the cabin is currently not recommended because the level of risk involved in the process is very high, but the firing compartment inside the cabin is designed to be provided to show the ideal conditions of the rocket launcher. Fire control outside the cabin can be done with a maximum distance of 60 meters.

4. CONCLUSION

In this study, it was found that the prototype of the X caliber 122 rocket launcher vehicle was in accordance with the requirements needed by the user.

This refers to the 4 (four) design requirements, namely, an appropriate support and slide delivery system, an appropriate turret system, an appropriate transporter system and an easy and safe operating system.

The achievement of the requirements for the prototype of the X 122 caliber rocket launcher vehicle can be a reference and consideration for further development, whether the vehicle with the same caliber is more optimized or developing a launch vehicle with a different caliber size.

ACKNOWLEGMENT

Thank you to all the parties involved for their help and cooperation so that this research can be completed. Thanks especially to Mr. Yogaswara and Mr. Nurahman for their guidance and direction during this research.

REFERENCE

[1] Litbang. 2017. Pengembangan prototype kendaraan peluncur roket R Han 122B TA 2017. Badan penelitian dan pengembangan. Kementerian Pertahanan. Jakarta.

[2] Litbang. 2018. Pengembangan prototype kendaraan peluncur roket R Han 122Btahap II. Badan penelitian dan pengembangan. Kementerian Pertahanan. Jakarta.

[3] Litbang. 2019. Pengembangan prototype kendaraan peluncur roket R Han 122B tahap II – II. Badan penelitian dan pengembangan. Kementerian Pertahanan. Jakarta.

[4] Miles,M.B, Huberman,A.M, dan Saldana,J. (2014). Qualitative Data Analysis, A. Methods Sourcebook, Edition 3. USA: Sage Publications.

[5] Poerwandari, E. K. (2007). Pendekatan Kualitatif Untuk Penelitian Manusia.Jakarta: LPSP3.

[6] R.C. Hibbeler. ____. Engineering mechanics. New York Statics. Prentice Hal Inc. Hal 4

[7] S.R Majumdar. 2001. Oil hydraulic system principle and maintenance. New Delhi. Tata McGraw-Hill publishing Co. Ltd. 2001 Hal 91

[8] S.R Majumdar. 2001. Oil hydraulic system principle and maintenance. New Delhi. Tata McGraw-Hill publishing Co. Ltd. 2001 Hal 93

[9] Sugiyono. (2018). Metode Penelitian Kuantitatif, Kualitatif, dan R&D. Bandung: Alfabeta.

[10] Sularso dan kiyokatsu. _____ Elemen mesin. Jakarta PT Pradya paramita

[11] Yin Robert K. (2019). Studi Kasus. Jakarta: Raja Grafindo Persada.

[12] Yusuf, A. M. (2014). Kuantitatif, Kualitatif, & Penelitian Gabungan.Jakarta: Kencana.