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Analysis of importance priority to be studied on igniter system of 450 caliber X rocket

A. Zaldiansyah[1*], N. Widianto[2], Y. H. Yogaswara[3], Y. Ruyat[4]
[1,2,3,4] *Faculty of Defense Technology, Indonesia Defense University, Indonesia*

*Corresponding author E-mail: zaldi.msn@gmail.com

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Abstract

A rocket is a flying platform that gets energy from the combustion process and performs a thrust that is large enough to reach hypersonic speed. It becomes quite vital considering the speed of the combustion process in double configuration propellant type, which is r=7 mm/s. The ignition of the propellant is supported by a squib as a conductor of electricity to the igniter which will then conduct heat to the propellant in the rocket motor. The main focus of this research is to analyze the development potential in the X rocket igniter system. This research uses a Quantitative Method approach, with the research analysis using a Quality Function Deployment (QFD) approach. Based on the benchmark values obtained from each supporting instrument used in the 450 caliber X rocket igniter system, the results were obtained on a priority scale for the development of a rocket igniter system as an effort to overcome the igniter from malfunctions when the operating system is running. The results show that the instruments that need to be developed are the squib, pyrotechnics, emergency button, ground system and wiring system.

Keywords: *Rocket, Igniter System, QFD, Malfunction, Instrument.*

1. Introduction

Today, the development of military technology is increasingly being intensified. In Indonesia, it has a road map of seven national priority programs related to weapons technology. [1] The Road Map contains seven priority programs for the national defense industry, including rockets and propellants which are one of the main focuses in research and development. There is ongoing research, namely the R Han 450 mm rocket which is deemed necessary and requires a lot of research in its development. Procurement of missiles and rocket is an important stage, in order to fulfil a minimum basic strength or known as Minimum Essential Force (MEF) in Indonesia. [2]

A rocket is a flying platform that gets energy from the combustion process and performs a thrust. [3] The resulting force is also large enough to reach hypersonic speed so that the reactive impulse will be proportional to the reaction, this is in accordance with Newton's third law of motion. [4]

Based on research by Ganda Samosir in 2011 on the propulsion of RX.320 rocket, [5] although it has a high flash point, this is quite vital considering the speed of the combustion process in double configuration propellant type, which is r=7 mm/s. The ignition of the propellant is supported by a squib as a conductor of electricity to the igniter which conducts heat to the propellant in the rocket motor. [6]

Squib is part of the igniter of a rocket motor to ignite by electric a primary composition of the squib and some pyrotechnics. Squib is an electric ignition wick. [7] Depend on the speed of electricity flow on the squib, efforts are needed in conditioning the flow of electricity contained in the squib, so that an igniter can avoid

static electricity and unwanted disturbances.

Therefore, there is a need to analyze the importance priority to be studied on of the rocket igniter system to avoid malfunctions of the system.

2. Research method

This research was conducted using a quantitative method approach using a Quality Function Deployment (QFD) method. QFD is a method to transform qualitative user demands into quantitative parameters, the user requirements data that has been obtained is interpreted to find relationships and interrelationships between existing data descriptions. [8]

Thus, the data is obtained in the form of scores on the design characteristics of each instrument, and a priority scale is obtained.

3. Results and discussions

3.1. User requirements

User requirements explain the needs desired by users who in this study are the Firing - Igniter Team from the Rocket Technology Center (Pustekroket) BRIN in Indonesia. In this operation, there are several main points of user requirements that are desired for the purposes of the igniter system, which refers to the X rocket as outlined in the List of Requirements (LOR), as follows.

Table 1. List of Requirements (LOR)

Instruments	User Requirements	Urgency
Power supply	Electric current requirement of 1 Ampere and voltage requirement of 20 Volt	4
Switch connector	An emergency system is needed in the electrical panel box to be able to immediately cut off the current when something unexpected happens	5
Cable	Proper cable are needed for 1 Ampere and 20 Volts, and have low resistance so that the time delay in igniter operation can be cut	4
Grounding	The grounding system required when operating the igniter is integrated with the firing system, and is expected to have a minimal resistance value, so that the static electricity contained in the wiring can be wasted towards ground	3
Casing	The main casing needs are the Melting Point of 600°C, the distribution of combustion is even, and the casing melts instantly	5
Squib	It takes a squib that has a long shelf life, and is not easily oxidized at room temperature	3
Squib Explosives	Requires high calorific value, low flameability	4
Propellant Material	It requires a high calorific value, with the same flameability as that produced by an igniter flame	4
Igniter explosives	Requires high calorific value, low flameability	4

Description for Table 1:
- Score 1: Not important.
- Score 2: Less important.
- Score 3: Quite important.
- Score 4: High importance.
- Score 5: Very high importance.

Based on the table above, data on user requirements related to the igniter system are obtained according to user interviews. The points of need are discussed for each component, in order to make it easier for the author to classify needs and their level of importance.

3.2. Benchmark instruments

Based on Table 1 List of Requirements (LOR), then the relation matrix stage is carried out. Where the relation matrix is the match between the LOR points and the processing of the design characteristics made. There are 2 processes at this stage, namely providing benchmark values, and a priority scale of design characteristics, to determine the development potential of each instrument supporting the igniter system on the X rocket.
In making the relation matrix, there is a level of conformity that is divided into 3 with descriptions of weak linkage (1), moderate correlation (3), and high correlation (9). The relationship matrix was created to determine the relationship between the level of conformity between user needs and the characteristics of the design made. This criterion is based on the LOR compiled and analyzed using Quality Function Deployment (QFD). Then the relationship between user requirements (List of requirements) and design characteristics is arranged in a relation matrix. The following relationship data are shown in Table 2.

Table 2. Relation matrix

List Of Requirement	Level of interest	Design Characteristics						
		Power Supply	Cable	Ground	Casing	Squib	Pyrotechnic	Emergency Button
2 Volt and 1 Ampere	4	9	9	9	1	9	1	9
Circuit Breaker	5	9	9	9	1	3	3	9
Low resistance	3	3	9	9	1	3	3	9
Melting Points and even distribution of burning	5	1	1	1	9	3	9	3
Long storage time	4	3	1	1	3	9	9	3
High heating value	4	1	1	1	1	9	9	3
High sensitivity value	4	1	9	9	1	9	9	3
Final score (Level of importance x design characteristic)		115	157	157	77	183	181	159
Benchmark Performance (%)		44.06	60.15	60.02	29.05	70.11	69.35	60.9
Priority Scale		6	4	5	7	1	2	3

$$Benchmark\ Performance = \sum_{Criteria\ 1}^{Criteria\ 8}(Importance\ Rating\ x\ Relation\ Value)$$

Description of Table 2:

a. Score 1: Weak Relationship.
b. Score 3: Medium Relationship.
c. Score 9: High Relationship.

Based on table 2. Relation Matrix and performance benchmarks, the values that have priority scale numbers 1 and 2 are squib with 70.11%, and pyrotechnics with 69.35%. There are also emergency buttons, cables and ground that have a priority scale value of 3, 4, and 5, each of which has a value of 60.9%, 60.15%, and 60.02%, respectively.

Based on the benchmark values obtained from each of the supporting instruments used in the 450 caliber X rocket igniter system, the results of the priority scale are obtained for developing the rocket igniter system to avoid from malfunctions. The results show that the instruments that need to be studied more are the squib, pyrotechnics, emergency button, ground system and wiring system.

4. Conclusions

Analysis of the importance priority to be studied on the igniter system of 450 caliber X Rocket has been conducted, the results of the identification of the need for an igniter system for the X rocket were carried out with a list of requirements, to ensure that no required requirements were missed. The results obtained in the form of user requirements data which include squib with a final score of 183 with a benchmark performance value (BP) of 70.11%, pyrotechnics with a final score of 181 and a BP value of 69.35%, emergency button with a final score of 159 and a BP value of 60.9%, cables with a final score of 157 with a BP value of 60.15%, Ground with a final score of 157 with a BP value of 60.02%, a power supply with a final score of 115 with a BP value of 44.06%, and casing with a final score of 77 with a BP value of 29.05%. The value obtained becomes a reference as an effort in conducting research and development, to avoid the igniter from malfunctions when the system is running.

Declaration of competing interest

The authors declare that they have no any known financial or non-financial competing interests in any material discussed in this paper.

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