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Risk Analysis of Dual Fuel Tug Ship Design in Maritime Technology Development Innovation Program – BRIN

Dewi Kartikasari[1, *], Muhajirin[1], Waluyo[1], Siti Sadiah[1], Dany H P[1]

[1)] Research Center for Transportation Technology, National Research and Innovation Agency (BRIN), Surabaya, Indonesia
* dewi003@brin.go.id

ABSTRACT
The problem that often occurs in the ship design process is the deviations in time and quality of results. IMO [1] regulations provide a methodology that ship design should be carried out with a risk-based probabilistic approach. This paper aims to become a source of reference information for ship design innovations in supporting efforts to increase performance optimization and efficiency. In the dual fuel tugboat design carried out in the BRIN Maritime Technology Development Innovation Program with funding from the government, the risk analysis begins with identifying and collecting data on control systems and internal controls based on existing risks, data collection on regulations, operational procedures, ship design business processes, and measuring the probability of risk occurrence. Furthermore, the level of risk is ensured by looking at the risk analysis matrix and making a risk map. The results of the analysis show that there are 3 risk events with a high-risk status that can lead to reduced quality and delays in the completion of the tugboat design, which is a skill base, experience, and the ship model test schedule.

Keywords: *Gap analysis, key plan design, dual fuel harbour tugboat.*

1. INTRODUCTION

Referring to the Regulation of the State Minister of Research, Technology and Higher Education, Republic of Indonesia, No. 38 of 2019 [2], regarding National Research Priorities for 2020-2024, one of the strategic plans for activities is to carry out technology innovation for dual fuel tug-boats. This technological innovation activity of ship design is an effort through a process of thought, research, development, study, and/or application that contains elements of novelty and has been implemented [3] and has provided economic and/or social benefits based on the Law of the Republic of Indonesia, Number 11 of 2019 concerning Systems National Science and Technology [4]. Assessment means activities to assess or find out the readiness, benefits, impacts, and implications before and/or after science and technology are applied, whereas the application is the utilization of science and technology research, development, and/or studies into engineering, innovation, and/or diffusion of science and technology activities.

This study aims to identify risks and analyze the value of risks and the level of risk acceptance utilization of the research. This study conducted a preliminary survey and direct interviews to validate risk indicators. These risks will certainly influence the performance of the implementation of activities, so it is necessary to conduct research related to the analysis of risks that may occur in the implementation of tugboat designs with costs charged to the Government Budget. These design activities must have high complexity, require considerable resources, numerous financing, and tight time constraints. The activities as set out cannot be separated from the risks that must be faced, so risk analysis must be carried out.

Risk factors can arise from design implementation errors, including designers who lack experience and knowledge in making design standards that can impact design failure and significantly contribute to increasing the cost and time frame of carrying out research activities. From the above background, this study takes the position of conducting a risk analysis on implementing a dual-fuel tug boat design to support efforts to provide risk information references to increase performance optimization, cost savings, and efficiency ship design proceeds in three phases: preliminary design, contract design, and construction detail design [1]. The preliminary drawings are conceptual and preliminary design drawings that be used in discussion with the client before the contract agreement and its need for further development of design drawing [2]. Once the preliminary design has been accepted and orders are given by the client, a set of contract design documents, drawings, and calculations is begun. During the Contract design stage, refinements are made to the Preliminary drawings and calculations, more details such as piping schematics and electrical calculations are done, and the weight, stability, and speed/power/range/fuel consumption estimates are updated as more details have become available, and the drawings necessary for a shipyard to bid on the building contract are produced [2]. These design documents and drawings shall comply with classification society rules requirements since the ship will be classed by the classification society (CS). The ship that will be an object of this report, be classed as the Biro Klasifikasi Indonesia (BKI), as chosen CS.

The plan used for the building process of the ship is called a construction detail design drawing or shipbuilding drawing. The number of plans can be divided into various groups based on the user. The groups are (1) to convey information pertinent to the design engineers and (2) the various craft personnel that does the construction. The first group is key plan documents and drawings as well as calculation papers, and the next is working detail documents and drawings. Both groups are produced by the engineering working group [2] and correlate with each other. In the general procedure of shipbuilders, the working detail documents and drawings will be made after the key plan documents and drawings are approved by chosen CS. Chosen CS reviews and assesses the documents and drawings on the conformity with chosen CS rules that the shipbuilder submits to the chosen CS. Once the process of review and assessment is done, the chosen CS will provide the decision that the submitted documents and drawing are (i) approved, (ii) approved with a comment, or (iii) not approved. If the results are (ii) or (iii), this means a difference gap between chosen CS plan approval engineer and the engineering working group. In order to solve these issues, it is needed to conduct a gap analysis.

Gap analysis is either a tool or a process to identify where gaps are and what differences exist between a condition's current performance and "what ought to be" in the condition [3]. In this paper, we concern with the activities of the design of the Dual Fuel Harbour Tugboat (DF Tug), which was conducted based on the applicable requirements contained in the Regulation of the Minister of Transportation (PM) of the Republic of Indonesia No. 93 of 2014 concerning Ship Guiding Auxiliary Facilities and Infrastructure, also based on the Minister of Transportation of the Republic of Indonesia No. 57 of 2015 concerning Ship Guiding and Towing [4,5]. The increasingly stringent regulations regarding limiting the levels of exhaust gas particles such as CO, Sox, NOx, etc. and Circular of the Director General of Sea Transportation No. SE. 35 of 2019 dated 18 October 2019 concerning the Obligation to Use Low Sulfuric Fuel which is the target of the International Maritime Organization (IMO) to reduce exhaust emissions from ship operations [MARPOL 73/78]. In terms of a ship, construction design is referred to under BKI rules. Moreover, the design of DF Tug shall comply with the applied rules, regulations, and standards.

Through gap analysis, the engineering working group seeks to improve its current key plan drawing to reach the desired situation in the ship design of DF Tug. The gap analysis results indicate the critical areas where we should take action to narrow the gaps and offer an objective and detailed glimpse at the direction and size of gaps among involved constituents. Gap analysis contributes to devising the engineering working group's implementation plan and improving its function and organizational effectiveness in many different areas of teamwork. These can include a management system such as human resources or resource planning, engineering tools such as hardware and software, ship standard and regulations implementations, information technology, and so on [3]. All of them can refer to factors of the design need, coherence, accuracy, communication intensity, quality of teamwork, and value [6]. This paper will explain the gaps which occurred in the ship design activities of the DF Tug and the effort to minimize the gaps in terms of compliance with the applied rules, regulations, and standard.

2. RESEARCH METHODS

2.1 Research Design

The research was conducted through quantitative descriptive methods (assessment with scales and numbers) and qualitative descriptive methods of solving quantitative problems and presenting data. Respondents for this risk research are experienced parties and are directly involved in the implementation of ship design activities.

2.2 Data Sources

The data used for this research are primary data and secondary data. Primary data is data obtained directly from the field in the form of a list of risks that occur in the implementation of ship design activities. The secondary data used is the result of research related to risk. Respondents for the research were determined by a certain sample (purposive sampling) consisting of the management of the activities to survey the risk of ship design and the process of implementing the tug boat design and have to experience and are directly involved in the research activities of the Government Agency.

Respondents for the implementation of this risk analysis came from the activity implementation team and resource persons from the work unit, namely the program director, knowledge manager, program head, chief engineer, program manager, group leaders, leaders, and staff engineer, as follows:

Table 1. Respondents of ship design risk survey

No	Respondents	Number	Work experience
1	Program Director	1	≥ 25 years
2	Chief Engineer	1	≥ 25 years
3	Knowledge Manager	1	≥ 25 years
4	Program Manager	1	≥ 25 years
5	Group Leaders	3	≤ 20 years
6	Assistant Chief Engineer	4	≥ 20 years
7	Assistant Program Manager	3	≤ 15 years
8	Leaders	6	≤ 15 years
9	Staff Engineer	10	≤ 10 years
	Number of respondents	30	

The ship design implementation facility is equipped with various software and hardware and a sub-scale model test laboratory, including the hydrodynamics laboratory in Surabaya. Work standards, class regulations, national laws and regulations, and other related regulations serve as a reference for the implementation of ship design.

In carrying out cooperation of technology services and business activities, there are 2 classifications of business processes in technology innovation activities: for users who need technology services and the public service agency team responds. Furthermore, the supporting administration is issued as a collaboration document between the Technology Service Center and the User or Customer. All requirements are given by the User as required in the engineering process. Furthermore, the results of technological innovation are handed over directly to the User according to the text of the Cooperation Agreement. Second, based on the Government's Work Plan, the Work Units carry out technological innovations through their competencies and main tasks. Communication with business partners and customers in general from Government Institutions, Universities, and state-owned enterprises is initiated to create program synergies. Further technological innovation activities are carried out based on the commitment of each related party based on a cooperation agreement.

The innovation ecosystem shows how the system provides outputs, outcomes, interactions, logical steps, and impacts based on the roles of all parties involved. This innovative ecosystem shows the reciprocal linkages between related parties in producing products and impacts as expected. This success becomes a success that is felt and achieved together. In this case, the success of the national shipping industry is increasing competitiveness. It is a mutual understanding that technological innovation is carried out in a multi-disciplinary, multi-competent, and multi-unit work and even multi-institutional manner, each of which has a specific role and authority, technology networks, information networks, competency networks, work networks, and synergistic and mutually beneficial fulfillment networks are a measure of the reliability of the technological innovation ecosystem.

The National Research and Innovation Agency, the Indonesian Classification Bureau, and the Shipbuilding Industry companies will take a role in implementing the tugboat design. Regarding the design results, it will relate to the needs of institutions, such as PT Pelindo, International Port Operators, and PT Pertamina Trans Kontinental. In terms of shipbuilding implementation, it will be related to the National Shipbuilding Industry.

3. DATA ANALYSIS

3.1 Risk Identification

Risk identification is carried out by compiling a list of risk events that occur in the implementation of ship design research activities based on the research that has been carried out. Furthermore, a preliminary survey was conducted on each respondent to choose what risk events occurred and did not occur according to the list that had been compiled.

Analysis approaches differ with respect to the orientation or starting point of the risk assessment and the level of detail in the assessment. An analysis approach can be: (i) threat-oriented; (ii) asset/impact-oriented; or (iii) vulnerability oriented [5]. A threat-oriented approach starts with the identification of threat sources and threat events and focuses on the development of threat scenarios. An asset/impact-oriented approach starts with the identification of impacts or consequences of concern and critical assets, possibly using the results of a mission or business impact analyses and identifying threat events that could lead to and/or threat sources that could seek those impacts or consequences. A vulnerability-oriented approach starts with a set of predisposing conditions or exploitable weaknesses /deficiencies in organizational information systems or the environments in which the systems operate and identifies threat events that could exercise those vulnerabilities together with possible consequences of vulnerabilities being exercised. Each analysis approach considers the same risk factors and thus entails the same set of risk assessment activities, albeit in a different order. Differences in the starting point of the risk assessment can potentially bias the results, causing some risks not to be identified. Therefore, the identification of risks from a second orientation (e.g., complementing a threat-oriented analysis approach with an asset/impact-oriented analysis approach) can improve the rigor and effectiveness of the analysis.

3.2 Risk Assessment

Risk-taking ability is an important step towards economic advancement, technological developments, improved quality of life, or successful adventures [6]. This is the key element in our modern economy. Taking unmanageable risks is capricious. Any industry or country needs to manage risks in its strides towards prosperity. Risks could be physical, economic, social, political, or moral; so risk management is challenging [7].

A preliminary survey and direct interviews were conducted to validate any risk indicators relevant to the research. Furthermore, risk analysis is carried out using the severity index (SI) method [8]. The Severity Index method is used to determine the probability and impact values, then categorize them based on the impact probability. After knowing the value that represents the respondents' answers, the analysis is continued by plotting the values into the probability and impact matrix. After knowing the value of the risk level, the level of acceptance of the risk is carried out to anticipate or minimize the risk. The assessment is carried out by compiling a questionnaire resulting from a preliminary survey containing the range of values for the frequency of risk events and the consequences of risk events on cost and time. The assessment data scale for the frequency of events, the consequences of cost performance, and the consequences of time performance use a Likert scale, and the value provisions of each Likert scale are based on interviews with the respondents [9]. The assessment ranges are shown in Table 2, Table 3, and Table 4 as follows:

Table 2. Occurrence Frequency Scale

SI	Severity	Effect on Human Safety	Effect on Ship	S
1	Minor	Single or minor injuries	Local equipment damage	0.01
2	Significant	Multiple or severe injuries	No severe ship damage	0.1
3	Severe	Single fatality or multiple severe injuries	Severe damage	1
4	Catastrophic	Multiple fatalities	Total loss	10

Table 3. Consequence scale of the effect of risk on-time performance

Consequence Level	Scale	Probability of Time Performance
Very Large	5	> 7 times in a year
Often	4	3 - 4 times in a year
Sometimes	3	2 - 3 times in a year
Seldom	2	1 - 2 times in a year
very rarely	1	1 time in a year

Table 4 Consequence Scale of the Effect of Risk Cost Performance

Consequence Level	Scale	Probability of Cost Performance
Very Large	5	> 0.15% from budget value
Large	4	0.10% - 0.15% from budget value
Medium	3	0.05% - 0.10% from budget value
Small	2	0.01% - 0.05% from budget value
Very Small	1	0.01% from budget value

Generally, the semi-quantitative method is complemented by a matrix known as the 'Risk Matrix' or 'Risk Map', which shows the relative position between risk events based on the impact's exposure rating and the risk's likelihood. Using the impact and probability criteria with 5 ratings, the 5 x 5 matrix is used. A categorization of the severity of risk based on the results of the calculation of the risk value. As for the SNI ISO 31010 document, the implementation approach is applied in the risk severity level technique [10]. Table 5 shows the categorization of the level of risk severity based on the results of the calculation of the risk value as follows:

Table 5. Risk Value of the level of risk severity

Risk Values	Level of risk severity
1 - 6	Low Risk
8 - 12	Height Risk
16 - 25	Extreme Risk

4. RESULTS AND DISCUSSION

4.1 Risk Identification

Risk identification is carried out by compiling a list of risk events according to the details of the implementation of the tugboat design and conducting a preliminary survey of the respondents of the management implementing the activities to select risk events. The preliminary survey results are then grouped according to the source of the risk. Based on the survey results obtained 7 (seven) groups of risk sources that are the preparation stage, field data survey stage, ship model testing stage, ship key plan design stage**,** class approval stage, stage of preparation of technical specifications, and the stage of socialization to prospective users.

In addition to risk identification based on the stages of the activity process above, risks can also be identified based on risk source factors, namely risks due to political, environmental, planning, marketing, economic, financial, natural events, projects, technical, and human factors [11]. The list of risk identification in the process implementation of tugboat design is shown in Table 6 and Table 7 as follows:

Table 6. Identification of risks based on activity stage

No	Description of activities	Risk identification
I.	**Preparation stage (X1)**	
X 1.1	Human resources mapping	The number of human resources (HR) who have more than 2 activities (multitasks)
X 1.2	Skill level, competence, ability, accountability, and experience	The competence of Ship Design HR has not met the requirements of skill level, competence, ability, accountability, and experience in, producing ship design standards
X 1.3	Functional Organization of Activity	Organizational Position Levels are often concurrently due to a lack of human resources
X 1.4	HR training/education	Lack of training/education (training about ship design)
X 1.5	Facility Resource Identification	Poor use of technology (Use of equipment or software in design)
X 1.6	Facility resources requirement preparation	Facility resources SDF requirement (software procurement)
X 1.7	Supporting hydrodynamic laboratory setup	The schedule is delayed a lot because it depends on the Support Laboratory in other units
X 1.8	SDF activity schedule	SDF Usage Schedule follows the schedule of other units
X 1.9	Coordination of lab test slots.	Optimizing the use of hydrodynamic laboratory test facilities
X 1.10	Activity budget mapping	Activity budget mapping is insufficient (there is a budget cut policy)
X 1.11	Budget planning	The budget for the implementation of the design and approval is very limited
X 1.12	Budget reporting	Budget absorption is not

No	Description of activities	Risk identification
		optimal/slow disbursement
X 1.13	Revised budget and activities	It takes a long time in the Budget Revision process and must be approved by the financial institution
II. Field data survey stage (X2)		
X 2.1	Ship data survey planning and collecting information	Collecting information about something that will be designed before the execution stage, such as objectives/designations, technical data, and the parties involved, all must coordinate with each other
X 2.2	Implementation methodology	Limited survey implementation according to the budget available
X 2.3	Data Needs	Very limited data availability
X 2.4	Preparation of questionnaires and respondent data	Limited competent of respondents
X 2.5	Technical coordination	Technical coordination with the survey objective unit takes a long time
X 2.6	Comparison Vessel data survey	Lack of comparison data survey and poor master plan definition
X 2.7	Comparison vessel data determination report	lack of existing data: data *traceable, accountable*
X 2.8	Availability of survey budget	Limited survey budget availability
X 2.9	Location of the survey destination	International port locations require survey time and long distance
X 2.10	Survey schedule	The schedule of the survey to the location is adjusted to the schedule of the destination
III Ship model testing stage (X3)		
X 3.1	Preparation of ship model data and drawings	Lack of existing data, and poor master plan definition
X 3.2	Ship model scale building	Availability of model materials and model-making budget
X 3.3	Preparation of technical personnel for ship testing	The availability of time for testing technicians in the laboratory is very tight and multi-tasking
X 3.4	Ship model test implementation schedule	The ship model test schedule follows the test schedule in the laboratory
X 3.5	Analysis of test results data and Reporting	The limited ability of HR to analyze the data from the model test results
IV Ship design and key plan design stage (X4)		
X 4.1	Design and Key plan Preparation (status review)	Lack of designer competence in the ship's design
X 4.2	Involving units in the Key plan Design stage	Involve external competent units in Design and key plan design
X 4.3	Involve partners in design and drafters	Involve external partners and drafters in the design
X 4.4	Preparation of design schedule and key plan	Adjustment of the design schedule according to the sub-contract schedule
X 4.5	Prepare a budget for External Designers/ Partners	Revise budget changes as needed for design optimization
X 4.6	Ship and propulsion system design	Involve external competent units in ship propulsion design
X 4.7	Dual fuel system design for ships	Involve external competent units in dual fuel system design
X 4.8	Stability booklet & other calculations (construction, weight, speed power prediction, electrical, bollard pull)	Involve external competent units in stability booklet calculations & other calculations
V. Class approval stage (X 5)		
X 5.1	Budget preparation for Approval Class	Insufficient budget: Design Fees (costs needed in the design process),
X 5.2	Preparation of calculation documents and drawings	Documents, calculations, and drawings are not up to standard and incomplete
X 5.3	The class approval application process and design integration	Design Integration: There are several corrections and improvements to the key plan drawing approval
X 5.4	Class Inspection process	Schedule Inspection of design drawings following the regulations of the Indonesian Classification Board-BKI
X 5.5	Key plan drawing improvements and enhancements	Lack of experience in the key plan design
X 5.6	Standard documents, calculations, and drawings	Documents, calculations, and drawings are not up to standard and are incomplete, resulting in the quality of the design results
VI Preparation of technical specifications stage (X6)		
X 6.1	Hull construction calculation	There are modifications and changes in the hull construction design
X 6.2	Machinery calculation	There are modifications and changes in machinery design
X 6.3	Electrical Outfitting calculation	There are modifications and changes in the electrical design
X 6.4	Navigation and Communication Calculations	There are modifications and changes in navigation and communication design
X 6.5	Gathering information on budget & vendor	Changes in budget and Vendor Needs due to changes in technology
VII. Socialization to potential users stage (X 7)		
X 7.1	Strengthening the innovation ecosystem	Strengthening the innovation ecosystem for user trust
X 7.2	Identification of potential Users for utilization of ship design	Identification of potential users for the utilization of ship design is very limited
X 7.3	Exploration of partners for utilization of ship design results	Partners are still in doubt and waiting for the results of the ship design trial
X 7.4	Preparation of Memorandum of Understanding & the Cooperation Agreement	Involving other internal HR units that are competent in the field of cooperation and law

No	Description of activities	Risk identification
X 7.5	Implementation of the Cooperation Agreement	Availability of budget and human resources for the implementation of the Cooperation Agreement

Source: Interview Results of Respondents Implementing Activities

Table 7. Risk Identification based on risk factors

Risk Factor	No. Factor	Risk Identification
I. Human Resources (HR)	X 1.1	The number of HR who have more than 2 activities (multi-tasks)
	X 1.2	The competence of Ship Design HR has not met the requirements of skill level (level of expertise), Competence, Accountability (calculations and assumptions based on accurate data)
	X 1.4	Lack of training/education (training about ship design)
	X 2.4	Limited competent of survey respondents
	X 3.3	The availability of time for testing technicians in the laboratory is very tight and multi-tasking
	X 3.5	The limited experience of internal HR involved in the ship's key plan design
	X 4.1	Lack of learning at the team or function: Level lack of designer competence in the ship's key plan design
	X 4.2	Involve other HR competent units in key plan design
	X 4.3	Involve external partners and drafters in the key plan design
	X 4.6	Involve other HR competent units in ship propulsion design
	X 4.7	Involve other HR competent units in dual fuel system design
	X 4.8	Involving other HR competent units in Stability booklet calculations & other calculations
	X 5.5	Lack of experience in the ship design or any plan design
II. Organization	X 1.3	Organizational Position Levels are often concurrently due to a lack of human resources
	X 1.5	Poor use of technology (Use of equipment or software in design)
	X 1.6	Facility resources SDF requirement (software procurement)
	X 1.7	The schedule is delayed a lot because it depends on the Support Laboratory
	X 1.8	SDF usage schedule follows the schedule of external units
	X 1.9	Limited Lab Test Slots
III. Financial/ Budget	X 1.10	Activity budget mapping is insufficient (there is a budget cut policy)
	X 1.11	The budget for the implementation of the design and approval is very limited
	X 1.12	Budget absorption is not optimal/slow disbursement
	X 1.13	Project implementation is done badly. It takes a long time in the budget revision process
	X 2.2	Limited survey implementation according to the budget available
	X 2.8	Limited survey budget availability
	X 5.1	Design Fees (costs needed in the design process),
	X 6.5	Changes in budget and Vendor Needs due to changes in technology
IV. Facilities	X 1.9	Optimizing the use of hydrodynamic laboratory test facilities
	X 3.1	Lack of existing data and poor master plan definition.
	X 3.2	Availability of model materials and model-making budget
	X 3.4	The ship model test schedule follows the test schedule in the laboratory
V. Research Project	X 2.1	Design Checks, Audits, and Reviews (no checks, audits, and evaluations were performed on the design results)
	X 2.3	Very limited data availability
	X 2.5	Technical coordination with the survey objective unit takes a long time
	X 2.6	Lack of comparison data survey and poor master plan definition
	X 2.7	Lack of existing data: data *traceable, accountable*
	X 2.9	International port locations require survey time and long distance
	X 2.10	The schedule of the survey to the location is adjusted to the schedule of the destination
	X 4.4	Adjustment of the design schedule according to the sub-contract schedule
	X 5.2	Documents, calculations, and drawings are not up to standard and incomplete
	X 5.3	Design Integration: There are several corrections and improvements to the design and key plan drawing approval
	X 5.4	Schedule Pressure: Design completion time is narrow
	X 5.5	Poor design integration (the design does not reflect the whole aspect of it.
	X 6.1	There are modifications and changes in the hull construction design
	X 6.2	There are modifications and changes in machinery design
	X 6.3	There are modifications and changes in the electrical design
	X 6.4	There are modifications and changes in navigation and communication design
VI. Technology Services and Cooperation	X 7.1	Strengthening the innovation ecosystem
	X 7.2	Identification of potential Users for utilization of ship design
	X 7.3	Exploration of partners for utilization of ship design results
	X 7.4	Preparation of Memorandum of Understanding & the Cooperation Agreement
	X 7.5	Implementation of the Cooperation Agreement

Based on the on-performance risk identification data in Table 7 above, matrix risk-performance in Figure 1 as below:

Frequency					
5	M=5	H=10	H=15	E=20	E=25
4	L=4	M=8	H=12	E=16	E=20
3	L=3	M=6	H=9	H=12	H=15
2	L=2	L=4	M=6	M=8	H=10
1	L=1	L=2	L=3	L=4	L=5
	1	2	3	4	5
	Consequence				

Figure 1. Quality performance of risk assessment matrix
Notes:
N= Negligible / Low risk, M = Medium risk, H= High risk, E= Extreme risk

Based on the results of the assessment of the effect of risk on the performance of design made in the distribution matrix, the value obtained is 3 (three) risk identifications which include acute (extreme) risk with a risk value of 15-25, namely risk identification numbers X1.2 Skill base and experience (expertise possessed, generally proven by a certificate), X 1.7 The ship model test schedule follows the test schedule in the laboratory, and X1.13 Project implementation is done badly. It takes a long time for the budget revision.

Then a risk value of 8-12 is high-risk, there are 12 (twelve) high-risk identifications, including risk identification numbers X 1.1 Multitasks, X 1.4 Lack of training/education, X 2.5 Technical coordination takes a long time, X 3.1 Lack of existing data, X 4.1 Lack of learning in the team or function, X 5.2 Documents, calculations, and drawings are not up to standard, X 5.5 Poor design integration, X 6.5 Vendor needs due to changes in technology, X 7.3 Exploration of partners for utilization of ship design results, X 4.3 Involve external partners and drafters in the key plan design, X 5.4 Schedule Pressure: Design completion time is narrow, X 5.5 Poor design integration (see Table 4.3). The total risk for which the risk response must be determined is 15 (fifteen) risks.

Furthermore, there are 22 (twenty-two) medium risks, namely risk identification numbers X 2.4 Limited competent of survey respondents, X 3.3 The availability of time for testing technicians, X 3.5 The limited experience of internal HR in the ship's key plan design, X 4.2 Involve other HR competent units in key plan design, X 4.6 Involve other HR competent units in ship propulsion design, X 4.7 Involve other HR competent units in dual fuel system design, X 4.8 Involving other HR competent units in Stability booklet calculations, X1.6 Facility resources SDF requirement (software procurement), X1.9 Limited lab test slots, X 1.10 A budget cut policy, X 1.12 Budget absorption is not optimal, X 2.2 Limited survey implementation, X 2.3 Very limited data availability, X 2.6 Lack of comparison data survey, and poor master plan definition, X 2.7 Lack of existing data, X 2.9 International port locations require survey time, X 2.10 The schedule of the survey to the location is adjusted to the schedule of the destination, X 3.2 Availability of model materials and model-making budget, X 4.4 Adjustment of the design schedule, X 5.3 There are several corrections and improvements to the design, X 7.4 Preparation of Memorandum of Understanding, X 7.5 Implementation of the Cooperation Agreement and there are 9 (nine) negligible/low risk, namely risk number X 1.3 Organizational Position Levels: lack of human resources, X 1.8 SDF usage schedule follows the schedule of external units,, X 2.1 Design Checks, Audits, and Reviews, X 6.1 There are modifications and changes in the hull construction design, X 6.2 There are modifications and changes in machinery design, X 6.3 There are modifications and changes in electrical design, X 6.4 There are modifications and changes in navigation and communication design, X 7.1 Strengthening the innovation ecosystem and, X 7.2 Identification of potential Users for utilization of ship design.

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4.3 Risk Response

The response to risk is applied to risk factors that have acute (extreme) and the high-risk category. High-risk response was obtained through interviews with the respondents. One way that can be done to respond to the influence of risk on the implementation of the tugboat design is to conduct a design review by experts who have experience in ship design and design reviews by stakeholders. Furthermore, all parties responsible for design errors are related to the design process [12]. The impact of design errors is that the results cannot be used or are not optimal, operations are disrupted, cost and time are and needed for repairs. There are several results of the assessment of the impact of risk on the implementation of ship design based on performance, cost, and implementation time, as shown in Table 8 below:

Table 8. Risk Response

No	Risk Identification	Risk Response
X 1.2	The competence of Ship Design HR has not met the requirements of skill level (level of expertise), Competence, Accountability (calculations and assumptions based on accurate data)	Conduct design reviews by experts and stakeholders responsible for the design results. As a ship designer, it is necessary to have training in ship design and increase learning at the team or function and designer competence in the ship's key plan design.
X 1.13	Project implementation is done badly. It takes a long time in the budget revision process	A monitoring and evaluation system of activities is required by the risk owner, namely the head of the work unit as the risk owner or a specially formed monitoring team.
X 3.4	The ship model test schedule follows the test schedule in the laboratory	It is necessary to plan a priority program schedule that involves all stakeholders.

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Based on the results of the risk analysis on the implementation of the dual-fuel tugboat design, the following conclusions are obtained:

1) The risk may change occasionally, in line with the dynamics of risk factors. Therefore, it would be excellent for research institutions always to carry out risk assessments faced against risk criteria periodically and continuously, depending on the dynamics of available resources, business environment and situation, skills, technology or systems, and so on that are relevant.
2) Based on the assessment of the effect of risk on the design performance, the value obtained is 3 (three) risk identifications. Where the risk factors that most influence the implementation of tugboat design research through funding from the government are those that are worth: Skill base and experience (expertise possessed, generally proven by a certificate). The ship model test schedule follows the test schedule in the laboratory, and Project implementation is done badly: It takes a long time in the budget revision.
3) Risk control can be done by redesigning the job, replacing the materials, machinery, or process, organizing workload to reduce exposure, identifying, and implementing practical measures to work safely, providing personal protective equipment, and ensuring workers wear it.

5.2 Recommendations

1) It is necessary to have a monitoring and evaluation system of activities by the Risk Owner, namely the Head of the Work Unit as the Risk Owner or a Monitoring Team that is specially formed, especially on the medium and high-risk criteria in the Risk Rating Map above, referring to the composition of the description of activities that have been prepared by the Risk Owner. Troika and Group Leader Activities.
2) It is necessary to have a recovery procedure for system failure as a result of a disaster or disaster based on various threats (from the results of risk assessment) and the impact that will be caused (from the results of Impact Analysis) [13].
3) It is necessary to conduct further and in-depth studies of how much impact the disruption of the ship design implementation process and service satisfaction will have on the Prospective Users or the community.
4) It is necessary to conduct a more in-depth study of the impact of system disruption on budget conditions.
5) It is not expected to eliminate all risks, but it is necessary to do everything 'practically enough' to protect people from harm. This means balancing the level of risk against the measures required to control the real risk in terms of performance, money and time.

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