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LIFE JACKET DESIGN AS SELF PROTECTION FOR TRADITIONAL FISHERMAN

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ABSTRACT

One of the personal protective equipment that fishermen must have is a life jacket. The existing life jackets basically comply with government regulations such as being brightly colored, able to float and have a whistle. However, the price of life jackets is considered relatively expensive, so fishermen often choose not to use or buy used life jackets. Materials for life jackets such as Neoprene, Nylon, and Polyester have varying characteristics and are adapted to the environment in which they are used. Implementation of RFID technology in life jackets increases identification efficiency and safety management in waters. The yellow color of the life jacket improves visibility in the water, especially in low light. The dimensions of the life jacket are informed by anthropometric studies, with an innovative design that allows development when needed. Assembly design efficiency shortened assembly time from 13201 to 5110 minutes through design improvements.

Keywords: Fisherman, Life Jacket, Design, DFMA. (Max 5 words, Seperated by comma)

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1. INTRODUCTION

Batam City is known as an industrial city and ship transfer. In addition, Batam is also an archipelago with 329 islands and a coastline of 1,261 km (Farizki and Anurogo, 2017; Lubis et al., 2018). Batam also has a wider ocean area than the mainland, namely 3,182.98 Km2, most of which has not been managed properly (Rohana et al., 2022). Marine resources include ecosystems of coral reefs, beaches and small islands scattered in several locations, one of which is in the Riau Archipelago Province. Regions in the Riau Archipelago Province have conditions of coral reef ecosystems that have the potential to be developed into marine tourism areas, with priority areas namely Natuna Regency, Lingga Regency, Batam City, Bintan Regency and Anambas Islands Regency. More than 95% of the Riau Archipelago Province (Kepri) area is marine waters, indicating that the potential for marine fishery resources is very large. Seeing the magnitude of this potential causes a large number of people to work as fishermen. Fishermen's safety and security is often overlooked or even ignored (Krisnafi et al., 2017).

Traditional fishermen often operate in dangerous and unpredictable waters. Bad weather conditions, high waves and strong currents are the main challenges faced by fishermen. As a result, the accident rate and loss of life among traditional fishermen is quite high. Personal protective equipment that is generally used by traditional fishermen today, such as traditional life jackets, tends not to meet adequate safety standards. However, bad weather conditions due to extreme climate change have caused very high and dangerous sea waves (Rohana et al., 2022). In addition, the unavailability of adequate personal protective equipment on traditional fishing boats has also exacerbated this situation. The potential for fishermen's deaths in Indonesian waters continues to increase from year to year. This information can be seen from the number of fishermen's deaths in 2020 of 251 people. If this condition is allowed to continue, it could lead to new problems because fishermen are asked to change professions to ensure their survival, both socially and economically. Solutions that can be offered to the above problems can be in the form of improving regulations and also equipping fishermen with personal protective equipment.

One of the personal protective equipment that fishermen must have is a life jacket (Spitzer et al., 2018). The existing life jackets basically comply with government regulations such as being brightly colored (Cox et al., 2022), being able to float and having a whistle. However, the price of a life jacket is considered relatively expensive, so fishermen often choose not to use or buy a used life jacket (Quistberg et al., 2014). Traditional fishermen often face limited financial resources which prevent them from buying or changing safety equipment regularly (Yang et al., 2023). High costs and limited accessibility to better personal protective equipment are also barriers to improving their safety at sea (Viauroux and Gungor, 2016). Even though this used Life Jacket has several weaknesses regarding its buoyancy. Apart from that, the Life Jacket also lacks information on usage which can be the cause of misuse and makes the risk of an accident even greater. In addition, the size of a Life Jacket that is too large requires storage. It is necessary to redesign the Life Jacket that can adapt to the needs of fishermen and function as a means of self-protection. Innovations such as lightweight and water-resistant materials, more ergonomic designs, automatic flotation systems and integrated communication technologies can provide better protection for traditional fishermen in the ocean.

The DFMA approach offers an effective framework for improving existing life jacket designs by considering manufacturing and assembly aspects (Lu et al., 2021). Through an in-depth analysis of the life jacket components and their production methods, the DFMA method enables the identification and simplification of components that can reduce production costs, increase manufacturing efficiency, and improve the quality and performance of life jackets (Razak et al., 2022).

2. METHODS

The research method implemented in this study uses the DFMA method where before entering into the DFMA method consumers' needs are first collected using a Fishbone

Diagram. To be more clear, the following are the stages of research as follows:

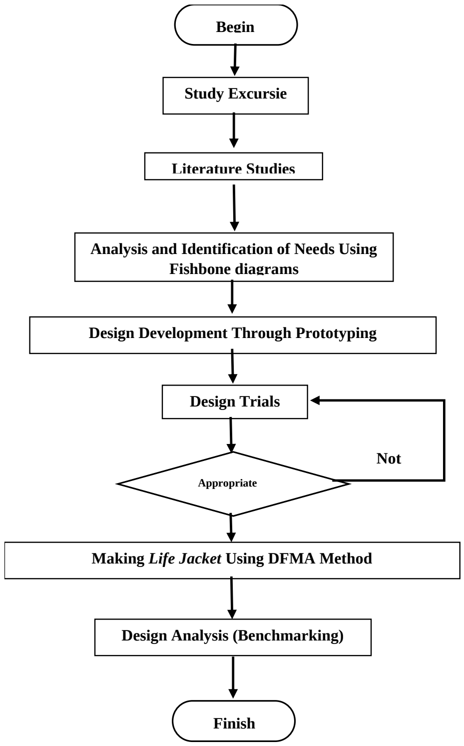


Figure 1. Research Stages

The description of the stages of research implementation is as follows:

1. Literature and Field Studies
   The stages of the research were carried out by collecting library sources, both primary and secondary. Through literature studies, some information is also collected or citing references. In field studies carried out through observation, documentation and interviews.
2. Analysis and Identification of Needs
   The stages of the identification and needs analysis process are carried out to find out the formulas for data processing, the tools and materials to be used, then the life jacket design is developed. To facilitate the identification of needs analysis using the Fishbone Diagram method.
3. Design Development
   The stages are carried out to develop an existing life jacket design using the DFMA method. Then do the making of the prototype of the life jacket.
4. Design Trials
   The resulting prototype will be tested to find out how successful the design is. Checking is also carried out on the results of the design related to the suitability of the design specifications that have been designed.
5. Design Analysis
   At the analysis stage, a comparison is made with the new design with the previous design.

3. FINDINGS AND DISCUSSION

3.1. Data collection

Main data or primary data is information obtained directly from the source and collected by researchers as a basis for conducting analysis and research. The following is an overview of life jackets that are generally used as an alternative by fishermen.

Gambar 1. Examples of Life Jackets

Here are the specifications of some of the buoys in the picture above:

Tabel 1. Life Jacket Spesification

No.	Types	Spesifications

1.	*Life-Jacket* Roho	- Weight: 250 grams - Bahan : Nylon Material - Dimension : 60x40x5 cm - Price : Rp. 89.000
2.	Jaket Pelampung Nearmount Life Jacket Cruiser	- Weight: 2.8 Kg - Fabric Material : Dolby - Inside Material : Polyfoam - Price : Rp. 280.000
3.	Jaket Pelampung Dewasa Nearmount Lifejacket Aquatic	- Weight: 2.1 Kg - Fabric Material : Ristop - Inside Material : Polyfoam - Price : Rp. 220.000
4.	Life Vest Jacket	- Material : Foam, Neoprene - Size : 56x42 cm - Thickness: 7.5 cm - Price : Rp.279.000

3.2. House of Quality (HOQ)

Then to find out what the fishermen need, a number of questionnaires are distributed. Through the questionnaire, the voices of customers (VOCs) were identified as follows:

Tabel 2. Voice Of Customer (VOCs)

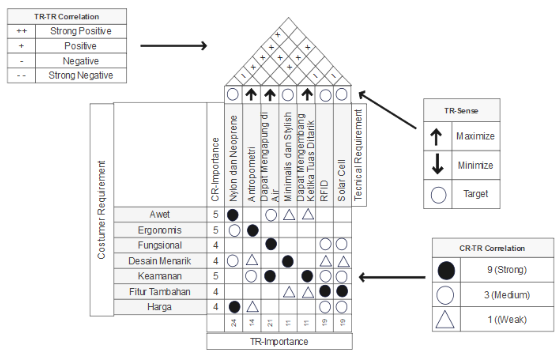
Voice of Costumer	Attribute
Quality	- Durable - Priced
Comfort	- Ergonomic - Functional - Minimalist and Stylish Design
Completeness of Safety Features	Security - Additional Function Components

Product specifications are obtained based on technical features according to user needs. The following is the voice of the customer, which has changed the technical requirements

Tabel 3. New Desain Spesification

Attribute	Technical Specifications
Durable	Nylon Fabric, Polyester and Neoprene Material
Ergonomic	Anthropometric Compliant
Functional	Can serve as a float
Minimalist and Stylish Design	Sling Bag Shaped
Security	May expand if pulled
Additional Features	- Sensor - Solar Cell - RFID

Product specifications for Life Jackets (life jackets) can be determined based on technical characteristics that are relevant to user needs. The following are some specifications that are generally obtained from the technical characteristics of a Life Jacket through the House of Quality (HOQ) in the following figure:



Gambar 2. House Of Quality

3.3. Anthropometric Measurements

After identifying customer needs using the HOQ, the life jacket components are identified. Beginning with taking measurements of fishermen around the Tanjung Uma area, Batam. The following are the results of measurements for fisherman data collected from 60 respondents.

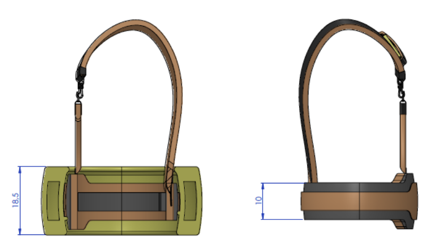
Tabel 3. Anthropometric Data

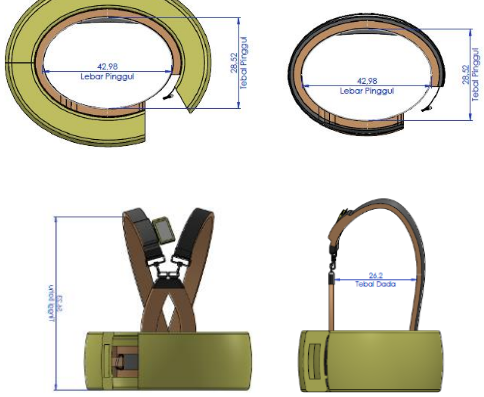
	Shoulder Height	Sitting Height	Hip Height	Top shoulder width	hip width	Chest thickness
P5%	130.13	50.72	89.01	34.76	40.24	22.77
P50%	133.63	56.23	95.12	38.12	42.98	26.20
P95%	137.14	61.75	101.23	41.48	45.73	29.63

In the context of the Sitting Shoulder Height (TBD) dimension, it is used as a guide for the float height dimension by selecting the 50th percentile. This is done with the aim that the height dimensions of the float cover the average size range represented by the samples taken. Furthermore, the Body Thickness (TB) dimension refers to the 50th percentile so that it can be easily applied as a vest width parameter. The Hip Width (LP) dimension was taken as the reference point for the hip width of the vest, applying a design principle involving a size range from the 5th to the 95th percentile. This approach allows adjusting the width of the float according to the variant used. In the end, the Head Width (LK) dimension plays a role in determining the width of the head circumference on the float, by selecting the 50th percentile, so that it includes the average value of the sample and provides a comfortable level of application.

3.4. *CAD Drawing*

Based on the identification of the constituent elements of the life jacket product, the next step involves improving the design through the application of the Design for Manufacture and Assembly (DFMA) method. This effort includes the potential for developing, incorporating, or deleting components in life jacket products.





Gambar 3. Usulan Desain Terbaru Life Jacket

3.5. ***Design For Manufacture And Assembly (DFMA) Life Jacket***

To carry out the design, the principles of DFMA (Design For Manufacture and Assembly) will be observed. By adhering to these principles, design improvements can be made through the application of the Design for Manufacturing and Assembly (DFMA) method by developing, combining, or eliminating components that are not needed or do not provide added value.

Design for Assembly (DFA) consideration should be given to all phases of the design process, but especially in the early stages. The designer should consider the ease with which components or subassemblies are assembled and plan alternative design options in order for the device to effectively evaluate the efficiency with both designs installed. Evaluation of component assemblability must be precise and accurate. This method often provides a clear process for appraising projects to assist the designer in evaluating progress resulting from specific design improvements. This method also serves as a motivational tool for designers. In both circumstances and to develop designs easily and cost-effectively at that conceptual phase.

Tabel 4. DFA Analysis Results Related to Time Requirements

Assembly Type	Existing Design		New Design	
	Operating Cost	% Cost Requirement	Operating Cost	% Cost Requirement
Cutting Pattern	25	6176	19	2231
Cutting Foam	28	4084	22	1881
Sewing	59	2749	27	879
Installation of Additional Components	31	192	20	119
Total	143	13201	97	5110

Tabel 5. DFA Analysis Results Related to Time Requirements

Assembly Type	Existing Design		New Design	
	Operating Cost	% Cost Requirement	Operating Cost	% Cost Requirement
Cutting Pattern	64230	20%	38671	24%
Cutting Foam	120478	37%	73986	46%
Sewing	63914	20%	18166	11%
Installation of Additional Components	74112	23%	30623	19%
Total	322735	100%	161445	100%

3.6. Discussion

Neoprene is a material used as an alternative to buoyancy materials. Neoprene is a type of synthetic rubber known for its good elasticity, water resistance and thermal insulation properties. Neoprene can be used as a cover in an ergonomic life vest design due to its softness, closed cell structure, fire resistance, and superior buoyancy compared to styrofoam material, with an efficiency rate of around 9.56%. Nylon also tends to be more durable and weather resistant, which is why it is more likely to be used in clothing or outdoor gear. Nylon is also a strong and fire-resistant material, although in terms of price it is slightly more expensive than polyester. Polyester is also commonly used in life jackets because of its weather resistance and ability to dry quickly. This material is also durable and wear-resistant.

In the context of maritime safety, Radio-Frequency Identification (RFID) technology has been integrated as a means of self-identification in life jackets (buoys) with the aim of increasing the efficiency of individual identification, facilitating faster rescue actions, and strengthening safety management in the aquatic environment. The use of RFID in life jackets allows unique and accurate identification of each user through the RFID tag attached to the equipment, providing important information such as identity, medical history and current location that can be accessed by rescue workers and authorized personnel. Thus, the implementation of RFID technology in life jackets has the potential to increase emergency response capabilities and minimize risks in high-risk situations in the aquatic environment.

Therefore, the choice of yellow as the dominant color in the life jacket is a decision based on multidisciplinary considerations and has a positive impact on safety, identification and visibility objectives in the context of accident prevention and rescue actions in the aquatic environment. Ergonomically, the yellow color has characteristics that accentuate human vision, especially in low light conditions or in choppy water. The use of yellow in life jackets can quickly communicate important messages to users and raise awareness of the importance of using personal protective equipment in the aquatic environment.

The dimensions or size of a life jacket (life jacket or life jacket) are very important in ensuring that the product can function effectively and provide optimal protection to its users. Where in the making of this life jacket it was carried out on a number of 60 fishermen to take their anthropometric measurements. From the measurement results, p50 is used as a reference size. Then the design is carried out and the dimensions for the newest life jacket are obtained, the hip width is 42.98 cm, the hip thickness is 28.52 cm, the chest thickness is 26.2 cm and the shoulder height is 56.23 cm. In addition, this life jacket is designed to be comfortable to wear so that its initial shape resembles a waist bag that can expand when the lever is pulled. The size of the waist bag when it is not used is 10 cm thick and when it is inflated it becomes 18.5 cm in size.

The efficiency of the assembly design indicates the comparison between the estimated time required for reassembling the product and the ideal time for assembling the product in the initial design. This ideal time is obtained through the premise that each component element can be easily managed and combined. Through the improvement, it can be seen that the time has decreased from the previous 13201 minutes to 5110 minutes.

4.CONCLUSION AND SUGGESTION

Materials for life jackets such as Neoprene, Nylon, and Polyester have varying characteristics and are adapted to the environment in which they are used. Implementation of RFID technology in life jackets increases identification efficiency and safety management in waters. The yellow color of the life jacket improves visibility in the water, especially in low light. The dimensions of the life jacket are informed by anthropometric studies, with an innovative design that allows development when needed. Assembly design efficiency shortened assembly time from 13201 to 5110 minutes through design improvements.

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