APPLYING DESIGN ALTERNATIVE APPROACH TO OPTIMIZE COMFORT, SAFETY, AND COST-EFFECTIVENESS IN THE REDESIGN OF ACCOMMODATION ROOMS ON THE SHIP KM TAREX 2

Achmad Difa Khoirul Mustain[1], Aang Wahidin[1], Rachmad Tri Soelistijono[1] Priyambodo Nur Ardi Nugroho[1*], Azza Nuha Salma Ashari[1]

[1]Shipbuilding Department, Politeknik Perkapalan Negeri Surabaya, Surabaya, Indonesia

E-mail: priyambodo@ppns.ac.id

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ABSTRACT

In late December 2021, the ship KM Tarex 2, owned by PT. Pelayaran Mandala Sejahtera Abadi, underwent its annual docking at PT. Tambangan Permai Raya. During this time, the ship was found to be in a state of disrepair, including its accommodation rooms. The ship's current condition, feedback from stakeholders, and financial considerations served as the catalyst for a comprehensive interior redesign, with a primary focus on enhancing comfort, safety, and economy. The interior redesign of the accommodation spaces on the ship KM Tarex 2 involved the exploration of two alternative design concepts. These concepts centered around the Owner's Room, Crew's Room, Messroom and Life Jacket Storage. Alternative Design 1 adopted a Contemporary Concept, while Alternative Design 2 embraced a Modern Minimalist concept. The selection process for these designs involved soliciting feedback from a panel of 18 individuals, consisting of 12 representatives from PT. Pelayaran Mandala Sejahtera Abadi, 3 individuals from PT. Tambangan Permai Raya, and 3 crew members of the ship KM Tarex 2. Ultimately, Alternative Design 1 garnered an average approval rating of 67% across all rooms, surpassing Alternative Design 2 in preference. The selected design alternatives were evaluated for compliance with regulatory standards, achieving a 100% compliance rate for each room and an average comfort rating of 40%. Additionally, the chosen materials, as determined through a Google Form questionnaire, included ALUMETAL brand ACP Materials for room lining and ceiling, along with Henan Fortovan brand LVT for ship deck covering. These materials received an average approval rating of 61%. Economically, the analysis of material costs demonstrated that the project could be undertaken without exceeding the ship's annual income, ensuring financial feasibility.

Keyword: Ship Interior Redesign, Accommodation Rooms, Design Concepts, Compliance, Material Selection

Introduction

Commercial ships, which operate as the core of Indonesia's economic distribution system, play an important role in transporting diverse cargo types, ranging from solids and liquids to gases, to specific locations throughout the island [1]. In contrast to the opulent top structures of passenger ships, which meticulously attend to the comfort of both passengers and employees, commercial vessels frequently contain less ornate cabins that are primarily meant to serve the basic needs of staff personnel. It is critical to emphasize that even in these practical situations, safety, security, and employee well-being remain top priorities [2].

Mandala Sejahtera Abadi Shipping works with PT Tambangan Raya Permai, a famous shipyard that specializes in ship repairs utilizing the Graving Dock technology, to maintain and improve the functioning of its fleet. One of the mainstays of their naval force is the KM Tarex 2, a commercial cargo ship carrying the flag of PT. Pelayaran Mandala Sejahtera Abadi [3]. This stable ship has crossed the seas of Java and Kalimantan in order to successfully disseminate cargo. The crew's daily work has been hampered by

discomfort caused by inadequate living circumstances, such as limited sleeping accommodations, worn-out beds, and outdated concept. There are also notable shortcomings in the field of safety equipment, as lifebuoys, life jackets, and fire extinguishers have decayed to the point of being useless. As a result of these severe shortcomings, the crew has a strong desire to seek major improvements in their living and working conditions.

In view of the operational issues and the crew's unwavering desire for changes, this research project aims to thoroughly examine and improve the interior design of the KM Tarex 2's activity space. Our research strives to create feasible solutions that not only meet industry requirements but also meet the crew's desire for a more comfortable, safe, and supportive working environment. Comfort, cost-effectiveness, and compliance with regulations (safety include) are the main factors we'll use as measurement to evaluate the design's feasibility.

The primary purpose of this research is to provide interior redesign options for the KM Tarex 2 Ship Accommodation that prioritize security, safety, and crew comfort while adhering to current ship code rules. To assure the profitability of the proposed redesign, also seek to optimize the ship's interior design to correlate with its financial capabilities.

Methodology

Problem Identification: The research endeavor initiated by focusing on the KM Tarex 2 ship, emphasizing a comprehensive evaluation of its accommodations, with a focus on aspects of comfort, security, and crew-related concerns. Financial constraints were identified as the primary obstacle to implementing internal changes.

Data Collection: A comprehensive dataset was amassed through the utilization of three distinct data collection methods:

1. **On-site Observation**: During the ship's docking at PT. Tambangan Raya Permai, detailed observations were carried out, with particular attention to the Accommodation Area. These on-site observations provided valuable insights into the ship's condition.
2. **Literature Review**: An extensive literature review was conducted, with a specific emphasis on interior design elements and broader concerns related to comfort and safety within maritime environments.
3. **Stakeholder Engagement**: Engagement with various stakeholders, including the ship's owner, surveyors, and crew members, was an integral part of the data collection process. Additionally, guidance from a lecturer with expertise in ship interior design was sought. Ship-related data was gathered, and the ship's interior was documented through photography.

Design Conceptualization, the design concept was centered on crew comfort, safety, and cost-effectiveness, drawing inspiration from Modern Minimalist and Contemporary interior design trends. Design Development, in accordance with the chosen design concept, the identified challenges, and regulatory guidelines, interior design proposals were developed. These concepts were visually represented through detailed 3D and 2D drawings. Alternative Designs, Multiple interior design alternatives were created based on the gathered data.

Design Selection and Material Choices: Collaboration with the ship's owner was carried out to select the interior layout from the proposed alternatives. Simultaneously, informed decisions regarding materials were made to align with the selected design. Regulatory Compliance, the selected design options underwent comprehensive evaluation to ensure adherence to maritime regulations, with a specific focus on safety and conformity with legal standards.

Financial Sustainability Assessment: An analysis of material efficiency was conducted to assess financial sustainability. This evaluation considered factors such as regulatory compliance and market conditions. The economic material efficiency analysis incorporated the total material requirements for lining, ceiling, and deck covering, as well as labor hours. Subsequently, the calculated material requirements were adjusted in accordance with the ship owner's annual income to determine whether the planned pricing remained within the allowed price limit (30% of the ship's annual income) stipulated by the ship owner.

Result and Discussion

1. Ship Overview and User Study

The KM Tarex 2 ship has been in operation for over three decades, primarily engaged in the

transportation of cargo, notably cement and sand, within the Java and Kalimantan waters. With a crew of approximately nine individuals, it has remained a crucial part of maritime operations in the region [4]. During its last maintenance in December 2021, significant repairs were conducted on the ship's hull, engines, and propellers, addressing vital operational aspects. However, the ship's accommodation area, where the crew resides and performs their duties, had not undergone substantial refurbishment in 32 years. This area is of critical importance for ensuring the crew's well-being, comfort, and safety. However, there were problems in budgeting and designing for this critical section.

The process began by looking at issues with the KM Tarex 2 ship's accommodations, focusing on comfort, safety, and budget constraints. Data was collected through observations during docking, reading about interior design and safety, and talking to stakeholders like the ship's owner, surveyors, and crew members. This data helped in creating a design concept focused on crew comfort, safety, and cost-effectiveness, inspired by today's design trends. Detailed alternative designs were made ensuring they met the reparation requirements and regulations. Working with the ship's owner and other related parties, the selection process was conducted to choose the final design from the two alternative designs that were created and its materials. Each design was checked to follow safety and legal rules. Material efficiency was also analyzed, making sure pricing fit the ship owner's annual income (within 30%).

The method of selection through voting was preferred because considering the numerous stakeholders involved, ranging from ship owners, several crew members, to material suppliers who are not all in the same location, it was more time-saving and efficient. Google Forms (GForm) was utilized for the voting process.

1. Design Objectives

The redesign effort primarily focused on key sections of the ship, including: Bedrooms for Ship Owners: These accommodations catered to key personnel, such as the captain, chief officer, and chief engineer. Crew's Bedrooms: Provisions were made for the boatswain, seaman, cook, electrician, and engineer. Mess Room: The dining area for crew members was considered a significant space. Life Jacket Storage: Safe and accessible storage for life jackets was also addressed. These design decisions were meticulously crafted, taking into account legal regulations and aiming to enhance crew comfort, safety, and cost-effectiveness.

2. Design Concept

a. Macro design concept

Modern Minimalist Design Concept:

The Modern Minimalist concept prioritizes simplicity, clean lines, and functionality. It embraces uncluttered spaces with straight lines and geometric shapes, creating a sense of order and serenity. A neutral color palette, featuring whites, grays, and beiges, maintains a calm atmosphere. Furniture is selected for its functionality and minimalist design. Open spaces, ample natural light, and minimal decor contribute to a feeling of spaciousness and tranquility.

Contemporary Design Concept:

The Contemporary design concept incorporates clean lines but introduces curves and organic shapes, resulting in a more fluid and dynamic interior. A diverse color palette, encompassing neutral tones and vibrant colors, adds depth and texture. Sleek, stylish, and functional furniture, often integrating modern technology, characterizes this concept. Artwork and artistic decor enhance the space's personality, and designated zones or areas for specific functions offer flexibility and visual appeal.

b. Micro Design Concept

In crafting the interior of the KM Tarex 2 ship, focus was placed on several key aspects: Design Selection: A choice between the modern minimalist or contemporary design was made to ensure simplicity and functionality. Color Selection: Each design option incorporates two to three color combinations to create a comfortable ambiance. Lighting: Evenly distributed LED/TL lights were used to ensure well-lit and user-friendly spaces. Ventilation: Prioritization of air circulation was achieved by utilizing both natural ventilation through existing windows and air conditioning to maintain comfort. Safety: Safety took precedence, with the inclusion of fire alarms, smoke detectors, extinguishers, life jackets, and sprinklers adhering to safety guidelines. Materials: Materials such as AHP, ACP, and ACCP were employed for walls and ceilings to meet safety standards. Vinyl Composite Tile (VCT) was used for flooring. Furniture: Furniture designs prioritized functionality and stability during the ship's journey, enhancing both comfort and safety. These design elements collectively aim to provide comfortable and secure accommodation on the KM Tarex 2.

3. Design Alternatives Visualization

Ship owner's cabin alternative design can be seen at Figure. Ship crew's cabin alternative design at Figure. Dining room alternative design at Figure. Storage alternative design Figure.

Figure 1. Ship Owner's Cabin Alternative Design 1 and 2

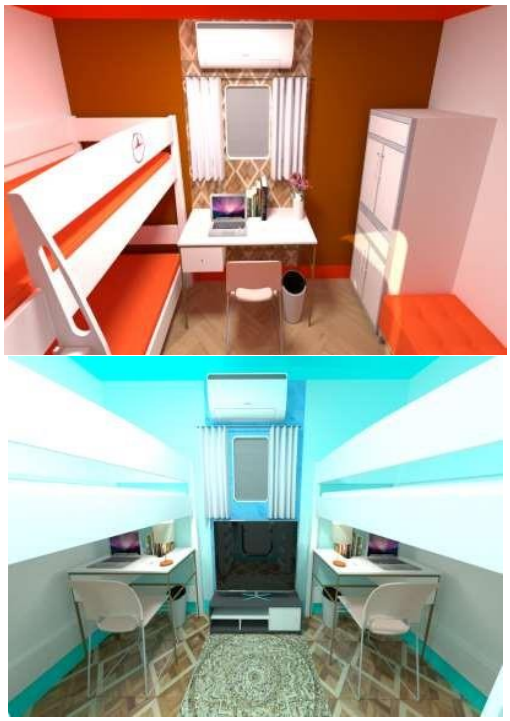

Figure 2. Ship Crew's Cabin Alternative Design 1 and 2

Figure 3. Dining Room Alternative Design 1 and 2

Figure 4. Storage Alternative Design 1 and 2

4. Design Selection

To select the most suitable design alternative, we conducted a thorough evaluation involving 18 participants who provided valuable insights. This group encompassed:

- 12 Ship Owners from PT. Mandala Sejahtera Abadi (MSA): Representing the ship's ownership, these stakeholders played a pivotal role in the decision-making process.

- 3 KM Tarex 2 Ship Crew Members (ABK): These individuals, who directly experience the ship's accommodations, provided crucial feedback.
- 3 Individuals from PT. Tambangan Raya Permai (TRP): As shipyard experts, their expertise and support contributed to the selection process.

The participant's' input was collected via a Google Form questionnaire, allowing them to express their design preferences. The voting results are summarized in Table 1 as follow, this collaborative decision-making process ensured that the selected design met the expectations and requirements of all key stakeholders involved.

Table 1. Summary of Voting Results

Room	Selected
Ship Owner's Cabin (Captain, Chief Officer, Chief Engineer)	Alternative Design 1
Ship Crew's Cabin	Alternative Design 1
Dining Room (Mess Room)	Alternative Design 1
Ship Owner's Cabin (Captain, Chief Officer, Chief Engineer)	Alternative Design 1
Storage (Life Jackets)	Alternative Design 1

5. Compliance with Regulations

Following an assessment of the chosen design's adherence to the relevant laws and regulations, the following is the result:

a. *Ship Owner's Cabin (Captain, Chief Officer, Chief Engineer)*
Compliance with regulatory requirements includes ILO Accommodation of Crews-Convention 1970 Part II: Crew Accommodation Requirements, (Section 3) ILO 1992 Crew Accommodation Requirements [5], SOLAS Consolidated Edition 2014: Ch. II-2 [6], and American Bureau of Shipping (ABS) Rules for Building and Classing: Steel Vessels 2013 [8].

b. *Ship Crew's Cabin*
Compliance with regulatory requirements includes ILO Accommodation of Crews-Convention 1970 Part II: Crew Accommodation Requirements, (Section 3) ILO 1992 Crew Accommodation Requirements [5], SOLAS Consolidated Edition 2014: Ch. II-2 [6], and American Bureau of Shipping (ABS) Rules for Building and Classing: Steel Vessels 2013 [8].

c. *Dining Room (Mess Room)*
Compliance with regulatory requirements includes ILO Accommodation of Crews-Convention 1970 Part II: Crew Accommodation Requirements, Marine Safety Directorate Transport Canada: Guide to Structural Fire Protection 1993 [5] [6], and American Bureau of Shipping (ABS) Rules for Building and Classing: Steel Vessels 2013 [8] [9].

d. *Storage (Life Jackets)*
Compliance with regulatory requirements SOLAS (2014) Chapter III/Reg.7-2 [7] which ensure the safety of people on board ships.

6. Comfort Aspects

Comfort aspects can be seen at Table 2.

Table 2. Comfort Variables and Parameters of Selected Design

Room	Selected
Thermal (Temperature, Circulation)	Good ventilation (e.g., air conditioning) to maintain room temperature and circulation.
	Use heat-resistant materials, especially near the engine room, to meet standards. [10] [11]
	Ensure 40% of space is free.
Audial (Noise)	Use sound-reducing materials.
Visual (Lighting and Color)	Use both natural (windows, etc.) and artificial lighting (as needed and per standards). [12] [13]
	Color application in rooms considers the psychological aspects of the occupants and matches the room conditions. [14]

7. Budget Compliance

According to PT. Pelayaran Mandala Sejahtera Abadi, the ship's owner, the ship's typical net income when fully laden is roughly Rp120,000,000.00 each month, for a total yearly income of approximately Rp1,440,000,000.00. When this yearly income is compared to the interior budget planning calculation, which is roughly Rp208,406,000.00, the percentage comparison between the total budget and the income of the KM. Tarex 2 ship is around 15%. This proportion is considerably within the permitted range and meets the criteria (maximum 30%). This study emphasizes

the financial viability of the interior redesign project, ensuring that it fits with the ship's profitability while staying within cost constraints.

The research findings shed light on the selection process and compliance aspects of the interior redesign project for the KM Tarex 2 ship. Collaborative decision-making involving ship owners, crew members, and shipyard experts ensured that the chosen design met everyone's needs. The fact that we met regulatory requirements and paid attention to comfort demonstrates a comprehensive approach to safety and comfort. Importantly, the budget analysis shows that the project is financially accepted, staying well within cost constraints and aligning with the ship's profitability. These findings suggest that the interior redesign for the KM Tarex 2 ship is well-planned and considers various important factors.

Conclusion

In conclusion, the interior makeover of KM. Tarex 2's lodging area resulted in two separate alternatives: contemporary and modern minimalist designs. While remaining loyal to the ship's primary concept, both alternatives establish a balance between simplicity, comfort, and contemporary aesthetics. Among these options, Alternative Design 1, which included a modern design, had a significant preference rate, with over 67% of respondents choosing it. Furthermore, a thorough examination of the chosen design option verifies full compliance with key standards such as ILO, SOLAS, ABS, and other specified recommendations. Fire extinguishers, sprinklers, and safety jackets, among other safety and comfort measures, were installed in strict conformity with requirements. The room free exercise test easily exceeded the 40% minimum threshold. Furthermore, the economic analysis shows that the chosen design alternative meets set standards, with the selected materials accounting for just 6% of the ship's yearly income. ALUMETAL ACP was chosen for the lining and ceiling of each room, while Henan Fortovan LVT was chosen for the deck covering. Both materials were overwhelmingly approved, with approval ratings over 61%. Finally, Alternative Design 1 emerges as a well-rounded option based on the modern notion. Within the thorough interior redesign of KM. Tarex 2's lodging area, it effectively satisfies the criteria of regulatory compliance, comfort improvement, safety reinforcement, and economic viability.

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