Ergonomic Evaluation of Speed Boat Passenger Seats in Derawan Island Using Anthropometric Data

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Abstract
This research aims to evaluate the ergonomics of passenger seating in speed boats used as a means of transportation in the Derawan Islands, Berau Regency, East Kalimantan. This evaluation was carried out by considering anthropometric data from the Indonesian people. Anthropometric data is used to design seats that suit the size and needs of passengers to increase passenger safety and comfort during travel. The research method involved collecting anthropometric data from Indonesian people of various ages and genders. This data is used as a basis for designing seating that suits variations in human body size. Ergonomic evaluation is carried out by considering parameters such as seat width, seat back, seat cushion width, seat height, and the distance between two seats. This research indicates that existing seating designs must meet the optimal criteria for passenger ergonomic needs. Therefore, recommendations for improving seating design are prepared based on the results of the ergonomic evaluation. This design improvement aims to increase passenger safety and comfort and reduce the risk of injury. This research contributes to developing more ergonomic seating designs for sea transportation, especially using speed boats in the Derawan Islands area. The results of the ergonomic evaluation and recommendations for improvements can be used by related parties to improve service quality and passenger safety in the Derawan Islands.

Keywords: Ergonomics, seating, speed boat, Derawan Island, anthropometry.

1 Introduction

Indonesia is an archipelagic country whose territory is mostly water. Water transportation is one type of transportation that is very important in the life and development of the country in Indonesia. A speed boat is a type of water transportation usually used to transport passengers or goods. People often use speed boats to connect one place to another [1]. It can also be used for tourism, such as visiting small islands or water sports activities [2].

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One example of using speed boats as a means of water transportation to meet tourism needs is in the Derawan Islands, Berau Regency, East Kalimantan. Speed boats usually cross the sea from Tanjung Batu to Derawan Island in this area. Speed boats are also used to get around the Derawan Islands using routes that can be adjusted to our needs [3]. Another example of using speed boats in this area is as a means of transportation to get to the Derawan Islands, apart from using airplanes and other land transportation.

The advantage of a speed boat is that this means of transportation has high speed, so it can reach a place faster than other means. People prefer using speed boat transportation. However, when operating a speed boat, safety and security factors such as weather and sea conditions must be considered [4]. Apart from that, the design of a speed boat must also consider ergonomic aspects so that passengers can travel safely and comfortably. Applying ergonomics in designing speed boats is also needed to eliminate complaints of fatigue or pain passengers feel in certain body parts such as the back, waist, neck, buttocks, etc.

Applying ergonomics in vehicle design emphasizes research on human capabilities to reach certain limits. So, systematically using ergonomics will utilize information about this to achieve design goals. That way, a desired product or system will be created by human needs. The ergonomic design will increase work efficiency, effectiveness, and productivity, creating a safe and comfortable work system or environment suitable for use according to needs.

2 Method

The method used in this research was conducted by conducting interviews with passengers or speed boat users in the Derawan Islands, Berau Regency, East Kalimantan. Problems with speedboat passengers were validated by conducting interviews and discussions with passengers regarding subjective complaints they felt. This method also involves collecting anthropometric data from Indonesian people of various ages and genders.

3 Result and Discussion

3.1 Ergonomic Evaluation of Speed Boat

Based on the results of the research, several evaluations were obtained for speed boats, including:

1. The designed seat width does not consider the passenger's body size. When designing the width of a seat, you should consider the width of the passenger's hips and shoulders. The speed boat has a total width of 200 cm and is usually filled with five to six passengers. So, each passenger is estimated to be allocated a seat size of 33 cm.

2. The backrest of a seat is used to increase passenger comfort. The height of the backrest on this speedboat needs to consider ergonomic aspects in its design, giving rise to several complaints from passengers.

3. The seat width should be designed, considering the size of the popliteal buttocks. The size that should be used should be obtained by measuring the horizontal distance from the outer part of the user's buttocks to the curve of the inner knee of the thigh and lower leg, which forms a right angle.

4. The seat height on a speed boat should be designed using a small percentile so that passengers can use the seat comfortably. Data from popliteal height is used to
determine seat height, which is obtained by measuring the vertical distance from the floor to the bottom of the passenger's thighs.

5. The distance between two seats must be taken into account. If the distance is too narrow, it will cause the passenger's knees not to touch, making them uncomfortable when sitting. How to determine the distance between the two seats at speed can be done using anthropometric data from the buttocks to the knees obtained by measuring the horizontal distance from the outermost part of the buttocks to the knees, where the position of the thighs and lower legs form a right angle.

6. The seats on the speed boat are equipped with foam. This foam is helpful for dampening vibrations so that complaints on the buttocks and surrounding areas can be reduced. However, the foam on speed boats cannot dampen vibrations very significantly, so it cannot eliminate the risk of miscarriage for pregnant women.

3.2 Ergonomic Design Recommendations

Based on the recap of the Indonesian people's anthropometric data, a design recommendation based on the ergonomic concept for seating on a speed boat is obtained as follows.

1. Seat width is determined based on anthropometric data on shoulder width. The average value of shoulder width is 51.16 cm, and the standard deviation is 7.54, which uses a large percentile (P95). In this way, an estimated ideal value for the seat width is 63.6 cm.

2. The backrest of a seat functions to increase passenger comfort. The size of the backrest is determined based on anthropometric data of height in a sitting position. The average height value in a sitting position is 95.28 cm, and the standard deviation is 10.44 cm, using a large percentile (P95). In this way, an estimate of the ideal value for the backrest size for the seat is 112.5 cm.

3. The width of the seat cushion is determined based on anthropometric data of the popliteal length dimension. The average value of the popliteal dimension is 49.65 cm, the standard deviation is 5.94, and it uses a large percentile (P95). In this way, an estimated ideal value for the seat cushion width is 59.5 cm.

4. In designing the seat height, the smallest percentile is used so that people with small bodies can use it comfortably. Seat height is determined based on anthropometric data of popliteal height dimensions. The average popliteal height dimension is 31.03 cm, and the standard deviation is 5.49, which uses a small percentile (P5). In this way, an estimated ideal value for the seat width is 22 cm.

5. The narrow distance between two seats means passengers cannot rest their knees comfortably. The distance between two seats is determined based on anthropometric data of knee length dimensions. The average value of the knee length dimension is 62.08 cm, and the standard deviation is 7.41, which uses a large percentile (P95). In this way, the estimated ideal value for the distance between the two seats is 74.3 cm.

6. The foam on the speed boat cannot dampen vibrations significantly. Existing foam cannot eliminate the risk of miscarriage in pregnant women due to vibrations caused by speed boats. For this reason, a softer and more elastic bearing design is needed so that vibrations from the speed boat are more dampened. Apart from that, more delicate cushions can reduce complaints from passengers in the buttocks and surrounding area. To overcome this problem, replace the pad material with a softer
and more elastic material, such as silicone. The size of the foam must be estimated so that the user can still use the chair with their feet ideally planted on the floor of the speed boat.

Table 1. Design of speed boat seating dimensions.

<table>
<thead>
<tr>
<th>Seating Section</th>
<th>Dimensions (cm)</th>
<th>SD</th>
<th>Design Size (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seat width</td>
<td>51,16</td>
<td>7,54</td>
<td>63,6</td>
</tr>
<tr>
<td>Seat back</td>
<td>95,28</td>
<td>10,44</td>
<td>112,5</td>
</tr>
<tr>
<td>Width of the seat cushion</td>
<td>49,65</td>
<td>5,94</td>
<td>59,5</td>
</tr>
<tr>
<td>Seat height</td>
<td>31,03</td>
<td>5,49</td>
<td>22</td>
</tr>
<tr>
<td>Distance between two seats</td>
<td>62,08</td>
<td>7,41</td>
<td>74,3</td>
</tr>
</tbody>
</table>

3.3 Potential Impacts

Based on the research results, several impacts were formulated that might arise due to the unergonomic design of speed boat seating. Some of the effects that can be caused are:

1. The narrow seating conditions cause speed boat passengers to sit in the wrong position, and their body posture is abnormal. It can trigger damage to the intervertebral disc. The intervertebral disc functions as a ligament to keep the spine connected and also functions as a shock absorber for the spine. If this part is injured, the intervertebral disc will flatten. Damage to this part will cause health problems such as back pain and functional disorders of muscles, ligaments, nerves, tendons, joints, and spine (MSDs/Musculoskeletal Disorders)[5].

2. Complaints in the skeletal muscles include aches and pain in the neck, shoulders, arms, waist, and legs [6]. It can arise because the designed seats do not contain ergonomic aspects, so the seats' condition does not take into account aspects of the human body's limitations.

3. Risk of heart disease, type 2 diabetes mellitus, obesity, muscle weakness, decreased brain function, and neck pain[7].

![Intervertebral Disc](https://doi.org/10.1051/shsconf/202418901006)
A seat designed without reviewing ergonomic aspects will prevent the user's body posture from being poor when using it. It causes users to feel tired more quickly.

3.4 Formula

In determining anthropometric-based design sizes, percentile values are calculated using the following formula.

\[ P_{kecit} = (\bar{x}) - 1.65\sigma \]  
\[ P_{rata-rata} = (\bar{x}) \]  
\[ P_{besar} = (\bar{x}) + 1.65\sigma \]

![Figure 2. Anthropometric Data Measurement](image)

4 Conclusion

Complaints experienced by passengers, such as soreness and pain in the neck, shoulders, arms, back, waist, and legs, as well as pain in the joints and other complaints, are due to the condition of passenger seats, which have not been designed to take into account ergonomic aspects. Besides that, tourism activities using speed boats in the Derawan Islands have yet to pay attention to ergonomic elements in creating the seating designs. Based on this, the author formulates the need for regulations by the local government to implement ergonomics and safety aspects so that the risk of injury or other undesirable things can be prevented. Apart from that, further research needs to be conducted regarding ergonomic speed boat seating designs adapted to user needs.

References

**Thesis**


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**Journal article**


**Web page**
