DESIGN SOLAR PANEL HOLDER E-BECAK YOGYAKARTA USING QFD APPROACH

Muhammad Faishal[1*], Okka Adiyanto[1], ,Hayati Mukti Asih[1] and Alfian Ma'arif[2]

[1]Teknik Industri, Fakultas Teknologi Industri,
Universiti Ahmad Dahlan, Jl Ringroad Selatan, Tamanan, Bantul 55191,
D.I Yogyakarta, Indonesia.

[2] Teknik Elektro, Fakultas Teknologi Industri,
Universiti Ahmad Dahlan, Jl Ringroad Selatan, Tamanan, Bantul 55191,
D.I Yogyakarta, Indonesia.

*Corresponding Author's Email: muhammad.faishal@ie.uad.ac.id

Article History: Received xxxxx; Revised xxxx; Accepted xxxx

ABSTRACT: This research focuses on the ergonomic development of solar panel holder on electric-becak (e-becak) Yogyakarta by using the Quality Function Deployment (QFD) method. The objective is to enhance the functionality and usability of solar panel holders by addressing user needs and ergonomic principles. The study employed a structured approach, beginning with the identification of user requirements through surveys and interviews. Subsequently, the QFD method was utilized to translate these requirements into design specifications. A pilot study involving 100 respondents from Manufacturing SMEs in Indonesia ensured the validity and reliability of the questionnaire used. The data collected was analyzed using SPSS IBM to determine the Cronbach Alpha value, confirming the reliability of the instrument. The results indicate that the proposed design improvements significantly enhance the user experience and operational efficiency of solar panel holders on e-becak. This study contributes to the field by providing a systematic approach to ergonomic product development and demonstrating the application of QFD in enhancing product design. The findings are expected to guide future research and development efforts in similar contexts.

KEYWORDS: *e-becak*, *solar panel, ergonomic, QFD*

1.0 INTRODUCTION

In recent years, technological advancements have significantly affected various sectors, including transportation. The evolution of transportation has seen a shift from traditional modes to modern modes, driven by the need for efficiency, sustainability, and convenience[1]. One of the traditional modes of transportation adapting to technological change is becak, especially in Yogyakarta, a city known for its rich cultural heritage and bustling tourism industry. Becak has become a quintessential part of Yogyakarta's transportation system, providing an eco-friendly and relaxing mode of transportation for locals and tourists alike.

However, the number of becak operating in Yogyakarta has been declining. This decline is largely due to the rise of modern transportation alternatives such as motorbikes, cars, and app-based transportation services, which offer better speed and convenience. Despite this trend, becak still has significant cultural and historical value, as well as the potential to contribute to sustainable urban mobility solutions.

In an effort to revitalize becak and make it more competitive with modern transportation options, there is a push to integrate technological advancements into its design. One such innovation is the use of solar panels to power electric rickshaws. This not only improves the functionality of the rickshaw, but is also in line with global efforts to promote renewable energy and reduce carbon emissions. The use of solar panels offers a sustainable solution by harnessing clean energy, thereby reducing dependence on fossil fuels and minimizing environmental impact.

However, the placement and design of solar panels on current electric tricycles has posed some ergonomic challenges for drivers. Ergonomics, the study of human efficiency in their working environment, is critical in designing transportation that is comfortable, safe, and user-friendly. Observations show that the position of the solar panel often obstructs the driver's view and does not suit their ergonomic needs. This mismatch causes discomfort and inefficiency, thus affecting the overall usability and attractiveness of electric tricycles.

To address these issues, this study aims to develop a more ergonomic solar panel placement on electric tricycles using the Quality Function Deployment (QFD) method. QFD is a customer-based planning process used in product development to ensure that the final product meets users' specific needs and preferences[2]"id":"ITEM-1","issue":"2","issued":{"date-parts":[["2021"]]},"page":"1-10","title":"Integrated approach to customer requirement using quality function deployment and Kansei engineering to improve packaging design","type":"article-journal","volume":"26"},"uris":["http://www.mendeley.com/documents/?uuid=8ebefb70-40cf-43f2-afef-4e88a9d29e33"]}],"mendeley":{"formattedCitation":"[2]","plainTextFormattedCitation":"[2]","previouslyFormattedCitation":"(Faishal, Mohamad, Jaafar, et al., 2021. The method involves translating customer requirements (what the customer wants) into technical requirements (how the company will fulfill those wants), ensuring that the product design is aligned with customer expectations[3].

The QFD approach consists of four main tools: Quality House, Part Deployment, Process Planning, and Manufacturing Planning. These tools help systematically convert customer requirements into appropriate technical descriptors and ensure that these descriptors are communicated throughout the production process [4]safety management system standards, and the safety culture of the ferry service provider, referred to as the safety quality function deployment (SQFD. In the context of this research, QFD will be used to collect and analyze data from solar-powered electric rickshaw drivers to identify their specific ergonomic requirements for solar panel placement.

The research involves a survey of solar-powered electric becak drivers along Malioboro Street in Yogyakarta, a popular and bustling area known for its high density of becak traffic. The survey will collect detailed information on drivers' requirements and preferences for solar panel placement, including aspects such as visibility, comfort, ease of access, and overall vehicle aesthetics. The collected data will be analyzed to identify important technical requirements that should be addressed in the design process.
The main objective of this research is multi-faceted. First, the research aims to ensure that the placement of the solar panels does not obstruct the driver's view, which is critical for safety and operational efficiency. Secondly, this research aims to improve the aesthetic appeal of the solar panels, making the rickshaw more visually appealing to potential passengers. Thirdly, the research aims to design a structure that integrates with the existing becak design, ensuring that the modifications made do not disrupt the traditional look and feel of the vehicle.

With these aspects in mind, this research aims to develop a solar panel placement that is not only practical but also aligned with the ergonomic needs of the driver. This alignment is expected to improve driver comfort, reduce fatigue, and increase overall becak operator satisfaction. In addition, well-designed solar panel placement can improve the operational efficiency of electric tricycles, thus making them more viable as a sustainable urban transportation option.

The importance of this research is not just limited to practical applications. It contributes to a broader discourse on sustainable urban transportation and the integration of renewable energy technologies into traditional transportation systems. The successful application of ergonomic principles in the development of solar panel placement for electric tricycles can serve as a model for similar initiatives in other cities and regions. This research highlights the potential to combine traditional modes of transportation with modern technological advances to create innovative and sustainable mobility solutions.

In addition, this research seeks to contribute to the sustainability and usability of traditional transportation methods through innovative design solutions. The application of ergonomic principles in the development of solar panel placement for electric tricycles is expected to improve driver comfort, operational efficiency, and acceptance of green technology in urban transportation. By improving the functionality and attractiveness of electric becak, this research aims to promote the use of green transportation in Yogyakarta, supporting the city's efforts to maintain its cultural heritage while embracing sustainable development.

2.0 METODOLOGY

Research Design
This research uses a descriptive research design, focusing on the development of solar panel placement on electric tricycles using the Quality Function Deployment (QFD) method. The research was conducted in Yogyakarta, Indonesia, specifically targeting the ergonomic improvement of solar panel placement to improve driver comfort and operational efficiency[5]

Participants
The participants of this study were electric becak drivers operating in Malioboro area, Yogyakarta. A total of seven drivers were selected using a purposive sampling technique to ensure that the participants had sufficient experience and were familiar with the operational challenges of the current solar panel installation.

Data Collection
Data was collected through qualitative and quantitative methods. A structured questionnaire was administered to the participants to collect data on their preferences and perceived problems with the existing solar panel placement. The questionnaire included both open and closed questions to gain comprehensive insights.

Instrument Development
The development of the questionnaire was guided by existing literature and expert consultation. The validity and reliability of the instrument were assessed through a pilot study involving 30 participants. Statistical tests, including Cronbach's Alpha, were used to ensure the reliability of the questionnaire [6].

Application of Quality Function Deployment (QFD)
The QFD methodology was used to translate drivers' needs into specific technical requirements. This process involves the following steps:

House of Quality (HoQ): This tool is used to identify and prioritize driver needs and translate them into design specifications.

Part Deployment: The identified specifications are broken down into components and sub-components required for solar panel placement.

Process Planning: Detailed planning of the production process required to meet the design specifications is carried out.

Manufacturing Planning: The final step involves planning the manufacturing process to ensure efficient and cost-effective production.

Data Analysis
The data collected from the questionnaire was analyzed using IBM's SPSS to determine the validity and reliability of the responses. Descriptive statistics were used to summarize the data, while QFD analysis provided a structured approach to align technical requirements with driver needs.

Results
The results of the study, including validity and reliability tests, are summarized in Table 3.2. The application of the QFD methodology resulted in a solar panel placement design that is ergonomic and does not obstruct the driver's view, has an attractive color and shape, and uses durable materials..

3.0 RESULT AND DISCUSSION

3.1 Establishing Customer Need

This study uses a questionnaire distributed to respondents in the city of Yogyakarta. The results of the distribution of open questionnaires to electric rickshaw drivers with solar panels containing the desires of the rickshaw drivers in the form and design of the development of the solar panel place to be made are as follows:

Table 1: Respondent requirement

No	requirement list from solar panel electric rickshaw drivers
1	Solar panel holder does not block the view
2	More attractive colors
3	More attractive shapes
4	Solar panel holder is placed on the back of the seat
5	Solar panel holder size does not take up space.

3.2 House of Quality (HoQ)

House of Quality is the preparation of QFD product or service planning which is usually done using a tool called the house of quality.

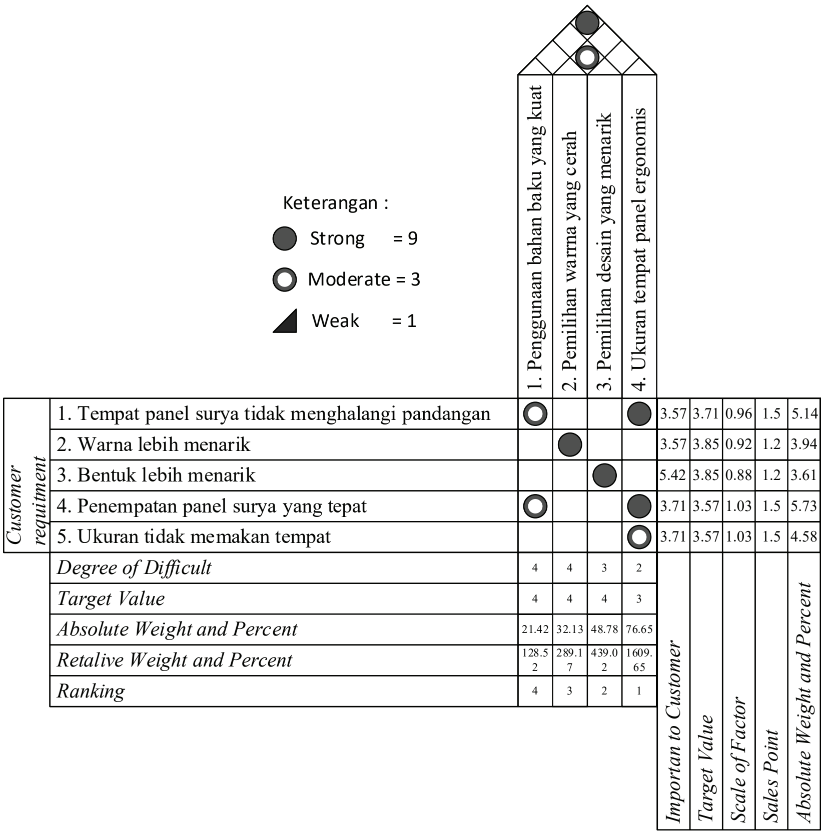

Figure 1: House of Quality

3.3 Part Deployment

This part deployment section is carried out by placing critical values obtained from HOQ and has been translated through the creation of Fault Tree Analysis in the form of a house. The following is a picture of the Part Deployment matrix and Column Weight calculation analysis:

			Critical Parts							
Technical Requirement	*Target*	*Column weight*	1. pemilihan jenis bahan	2. kekuatan bahan	3. Pemilihan jenis warna	4. Pemilihan warna	5. Penentuan bentuk tempat panel surya	6. Penentuan desain yang menarik	7. Penentuan ukuran tempat panel	8. Penempatan panel surya
1. Penggunaan bahan baku yanag kuat	1. Bahan baku yang tepat	128.42	●	●					○	
2. pemilihan warna yang menarik	2. Warna cerah	289.1			●	●				
3. pemilihan desain yang menarik	3. Desain berbeda dari sebelumnya	439.02			○	○	●	●	●	
4. ukuran tempat panel ergonomis	4. Ukuran dan penempatannya tidak mengganggu	1609.65		○			○		○	●

Keterangan :

● Strong = 9

○ Moderate = 3

◢ Weak = 1

Part Spesification	*Column weight*
1. Jenis bahan besi	1155.78
2. Tidak mudah patah dan keropos	5984.73
3. Warna Cerah	3919.59
4. Penggunaan warna biru	3919.59
5. Bentuk persegi panjang	8780.13
6. Bentuk produk menarik perhatian	3951.18
7. Dimensi tempat panel 55 Cm x 43 Cm x 6 Cm	9165.39
8. Tempat panel surya di belakang pengemudi	14486.85

Figure 2: Part Deployment

3.4 Manufacturing Planning

Manufacturing Planning is related to planning needs: Planning Need and Key Requirement. Manufacturing Planning of the Solar Panel Place product to be produced is as follows

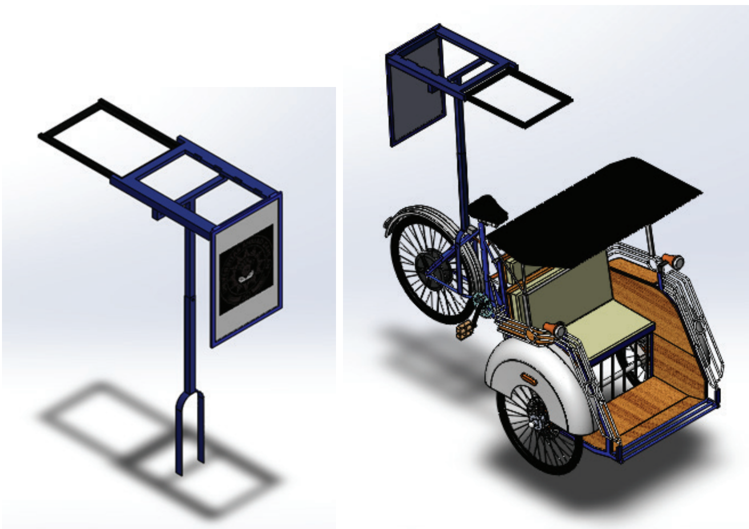

Figure 3: Draft design of solar panel holder on rickshaw

4.0 CONCLUSION

The design of the solar panel holder on the rickshaw with ergonomics in this study using the quality function deployment method with four tools namely house of quality, part deployment, process planning, and manufacturing planning with development based on the results of consumer desires and looking in terms of comfort and function of the rickshaw itself.

The design of the solar panel holder on the electric tricycle has the following sizes, the maximum height is 180 cm and the minimum height is 160 cm, the height of the product from the seat is a maximum height of 110 cm and a minimum height of 90 cm, the solar panel holder product has a length of 104 cm if in the open body slide position and when closed the length of the solar panel holder is 55 cm, The anthropometric data used is anthropometric data of the Javanese tribe with male gender and with an age range of 20-45, anthropometric data applied in the design of solar panel holder is human height in a sitting position with 95% percentile, and human head width with 95% percentile. To meet the wishes of pedicab drivers in the development of solar panel holder products, part specifications are obtained, namely the type of iron material, not easily broken, bright color, use of blue, rectangular shape, eye-catching product shape, and placement of solar panels behind the driver.

ACKNOWLEDGMENTS

The authors would like to thank the Lembaga Penelitian dan Pengabdian Masyarakat (LPPM) Universitas Ahmad Dahlan, Yogyakarta, Indonesia for financial support this research.

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