

## Design of Automatic Garbage Picker Tool

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### ABSTRACT

**Purpose**– This research aims to design and develop an Automatic Garbage Picker Tool as an innovative tool for collecting small waste from recycled materials that can improve work efficiency in the Cen Craft recycling community in Pekanbaru. Based on the results of surveys and interviews, it was found that the process of collecting waste materials such as plastic pieces and beads is still done manually using a broom and shovel. This method is inefficient, takes a long time, and has the potential to cause work fatigue for the craftsmen.

**Design/methodology/approach**–The research methods used include ergonomics & human factors approaches, product design & development, and design and manufacturing engineering. These approaches are applied in the design process of a semi-mechanical tool that utilizes an automatic rotating wheel and brush system without using electricity, so it remains energy efficient and environmentally friendly.

**Findings**– The design results show that the use of a mechanical system in this tool can speed up the cleaning process, increase work efficiency, and reduce the physical burden on the user compared to manual methods. In addition, the results of the SWOT analysis revealed that despite the weakness of limited capacity, this tool has advantages in terms of work efficiency, material durability, ease of operation, and commercialization potential for small communities.

**Originality**- This study provides an approach to designing tools to assist communities in addressing their problems.

**Keywords:** *Automatic Garbage Picker, Ergonomic, Mechanic design, Work efficiency, Cen Craft.*

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### Introduction

Product design is a crucial step in developing an innovation, designed based on shape, size, function, and user needs. The Cen Craft Waste Recycling Craftsman Community in Pekanbaru is an example of an environmentally-based creative economy actor that has been processing plastic waste into useful crafts since 2019. However, production activities are still carried out manually, resulting in suboptimal operational efficiency, particularly in handling and cleaning small-sized waste materials in the work area. While several studies on waste management have focused on electrically-based automated systems, this approach is not yet fully relevant for small-scale communities due to its higher cost, energy, and complex maintenance requirements. Based on these conditions, this study aims to design an Automatic Garbage Picker Tool as an ergonomic, easy-to-operate, and energy-

efficient mechanical solution to increase the effectiveness of the cleaning process and support the sustainable productivity of the Cen Craft community.

Previous research explains that the development of tools to assist in waste management and sorting plays a crucial role in improving efficiency, cleanliness, and supporting environmental sustainability. Automatic mechanical plastic waste sorting system based on conveyors and agitators can accelerate the waste sorting process at final disposal sites (TPA) (Siregar & Acmi, 2022). This research confirms that conveyor mechanisms play a crucial role in increasing the effectiveness of plastic sorting, but the equipment is still bulky, requires electricity, and is inefficient for small-scale environments or recycling communities.

(Siregar & Acmi, 2022) discusses technological advances in automated waste management systems. This system utilizes solar power and a hybrid power grid to support the device's sustainable operation. Although environmentally friendly, this research focuses on the digitalization and automation of waste bins, rather than the mechanical efficiency of the collection device, which can be operated manually without electricity.

Furthermore, (Putra et al., 2024) developed an Automatic Waste Sorting Device with an IoT System that can sort and shred plastic waste using an electric motor and sensors. This study emphasizes the importance of technology integration in increasing waste processing capacity. However, these tools still require high electrical power and are uneconomical to manufacture for small-scale communities. Therefore, it can be concluded that previous research has developed automated waste sorting and management systems based on digital and electrical technology, but no studies have focused on simple mechanical designs that are energy-efficient, ergonomic, and suitable for the work environment of recycling artisan communities. Therefore, the theoretical gap that emerges is the lack of a semi-mechanical, non-electrical waste collection tool that prioritizes motion efficiency, ease of operation, and effective collection of small particles such as plastic pieces and beads.

This study aims to fill this gap by designing an Automatic Garbage Picker Tool that integrates the principles of ergonomics and human factors, product design and development, and manufacturing engineering design. This tool is expected to provide a theoretical solution to the need for an efficient, environmentally friendly, and applicable cleaning system for small-scale artisan communities like Cen Craft.

## **Research methodology**

This research uses a descriptive-qualitative approach and product design engineering. The research stages begin with data collection through field observations and in-depth interviews with owners and community members to identify operational problems that occur, especially related to the process of collecting recycled materials (Ardiansyah et al., 2023; Kurnia et al., 2023; Zanariyah, 2024). The interview results are then analyzed using the fishbone method to map the factors causing the problems and SWOT to assess the strengths, weaknesses, opportunities, and threats of the community (Najiha et al., 2025; Perkasa et al., 2024; Widiawati & Wibowo, 2024). Next, benchmarking is carried out against several similar products available in the market to identify innovation gaps and specifications required by users. The tool design process is carried out by applying an ergonomics & human factors approach, product design & development, and design and manufacturing engineering, to produce 2D and 3D designs of the Automatic Garbage Picker Tool along with a Bill of Material and production cost estimation calculations.

## **Findings**

The first step is to identify the problems occurring within the community. This identification is accomplished through qualitative interviews with community owners and

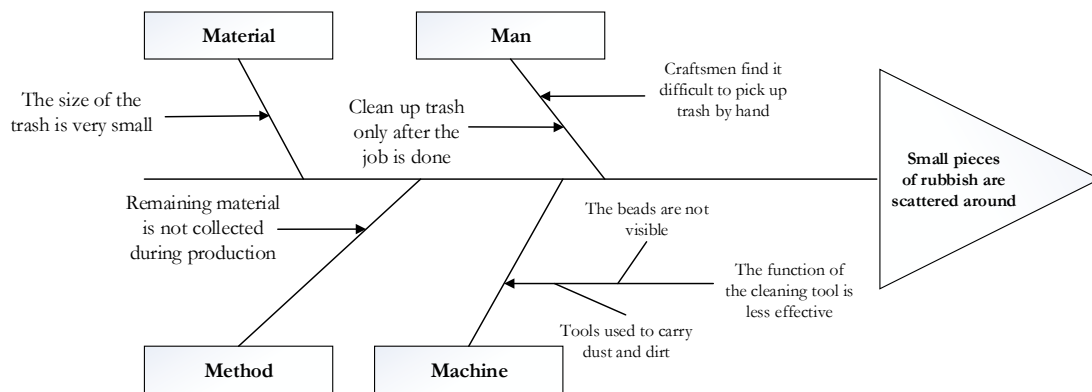
members (Dachrud, 2015; Zahroh et al., 2025). These interviews are intended to facilitate the identification of community issues and help improve the efficiency and effectiveness of activities.

**Table 1.** Interpretation of Community Problem Interview Results

| Interview Results                                                                                                                                                                                                                                         | <i>Interpretation</i>                                                                                                                                                | <i>Resource Person</i>  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| The community was initially founded by Ms. Silva Yenni, a housewife with an interest in handicrafts. Starting with a desire to fill her free time with positive activities, she developed the idea of utilizing used materials to create useful products. | The community was formed from the initiative of the founders who wanted to channel their hobby productively by utilizing used materials to create valuable products. | Respondent 1<br>(Owner) |
| The products produced include bags, wallets, drink baskets, tissue holders, ecobrick chairs, and home decorations made from used plastic.                                                                                                                 | The community already has a variety of recycled products with market value.                                                                                          | Respondent 1<br>(Owner) |
| Raw materials are obtained from household waste collection and the support of the local community, who also donate reusable waste.                                                                                                                        | Raw material sources still depend on community participation.                                                                                                        | Respondent 1<br>(Owner) |
| The production process is carried out manually, from sorting, cleaning, drying, and manufacturing.                                                                                                                                                        | The production system is simple and does not yet utilize assistive technology.                                                                                       | Respondent 2<br>(Staff) |
| Material collection is time-consuming because it is done manually and with simple tools.                                                                                                                                                                  | The work process is inefficient and still relies on human labor.                                                                                                     | Respondent 2<br>(Staff) |
| The tools used are still very simple, such as scissors, glue, a cutting knife, an iron, and a sewing machine.                                                                                                                                             | The community lacks modern tools, so the collection and processing of materials is slow.                                                                             | Respondent 2<br>(Staff) |
| Product marketing is carried out through social media platforms such as Facebook, Instagram, and TikTok, as well as through direct recommendations from consumers or word-of-mouth.                                                                       | Marketing is underway, but its reach is still limited.                                                                                                               | Respondent 1<br>(Owner) |
| The community hopes to grow with adequate tools and facilities to increase production.                                                                                                                                                                    | There is strong motivation to grow, but tool innovation and external support are needed to achieve work efficiency.                                                  | Respondent 1<br>(Owner) |

#### *Mapping Problems Using Fishbone Diagrams*

After identifying the problems occurring in the community through interpreting interview results, the next step is to map the problems using a cause-and-effect analysis method using a fishbone diagram (Damayanti et al., 2024; Ramadhan & Pujihartanti, 2025).



**Figure 1.** Cen Craft Fishbone Problem

The problem experienced by the Cen Craft Recycling Craftsman community is that the manual collection of plastic waste and other unused materials for making Ecobricks is still carried over. Manual collection using brooms and shovels is ineffective because it picks up dust and sand from the floor. Therefore, the craftsmen sort the remaining raw materials for use in making Ecobricks. The waste can include beads, plastic scraps, and other scraps of recycled materials.

#### *SWOT Analysis for Designing Tools to Address Community Problems*

A SWOT analysis is conducted to understand the conditions and potential of a community and to help identify community needs based on existing conditions and potential (Sasoko & Mahrudi, 2023). A SWOT analysis can lead to more focused designs that address community problems.

**Table 2.** SWOT Analysis and Community Potential

| Variable           | Interpretation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Strength</i>    | <ul style="list-style-type: none"> <li>– Eco-friendly products using recycled materials.</li> <li>– Unique and creative designs with high artistic value.</li> <li>– Low production costs because the main materials come from household waste.</li> <li>– Community activities have a positive impact on public awareness of waste management.</li> <li>– Utilization of leftover waste as raw material for making Ecobricks, which will then be used to make products for resale.</li> </ul> |
| <i>Weakness</i>    | <ul style="list-style-type: none"> <li>– Low productivity due to limited labor and equipment.</li> <li>– Variations in raw material quality result in inconsistent product results.</li> <li>– Work processes are inefficient because they still rely on human labor.</li> </ul>                                                                                                                                                                                                               |
| <i>Opportunity</i> | <ul style="list-style-type: none"> <li>– The trend for eco-friendly and sustainable products is increasing.</li> <li>– Opportunities for collaboration with external parties for equipment assistance or training.</li> <li>– Product marketing opportunities to attract consumers at events such as bazaars.</li> </ul>                                                                                                                                                                       |
| <i>Threat</i>      | <ul style="list-style-type: none"> <li>– Rapidly changing market trends require continuous product innovation.</li> <li>– Limited funding and access to equipment make it difficult to expand production.</li> <li>– Many other handicraft producers market similar products.</li> </ul>                                                                                                                                                                                                       |

The SWOT analysis reveals that Cen Craft's primary strength lies in its environmentally friendly, creative products with high social value. However, its most significant weakness is low work efficiency due to limited tools and labor. A significant opportunity arises from the market trend toward increasingly recycled products, enabling innovation in the production process to enhance competitiveness. The main threats stem from competition with other craft producers and limited funding. Therefore, simple technological innovations such as the Automatic Garbage Picker Tool can be a strategic

solution to strengthen the community's position in facing these challenges, while simultaneously improving productivity and the quality of work.

Mapping the opportunities and conditions faced by the Cen Craft recycling artisan community using the SWOT analysis method revealed the need for product innovation and limited equipment. These challenges led to the development of innovative products from Ecobricks, such as the Eco Sofa, and the development of tools that facilitate the collection of small waste materials, thus enhancing efficiency in Ecobrick production.

### *Product Design*

From the results of benchmarking competitor products, it was concluded that products with low prices tend to have less durable material quality, and have fewer features compared to expensive products. Conversely, products with high prices have more advantages, but the price offered is far above the average price of other Automatic Garbage Picker Tool products, making it a consumer consideration. From here, a market gap can be taken to create products with prices that can still compete with the market, but have quality, durability and complete product features. The component design and basic price of the Automatic Garbage Picker Tool are as follows:

#### *a) Raw Material Price*

**Table 3.** Raw Material Price Design

| Material                                | Volume                    | Cost             | Total Cost         |
|-----------------------------------------|---------------------------|------------------|--------------------|
| Stainless steel iron<br>(diameter 5 mm) | 30 cm                     | Rp 21.000/ 60 cm | Rp 30.500 (30 cm)  |
|                                         | 28 cm                     |                  | Rp 28.466 (28 cm)  |
| Broom bristles                          | 1 broom head              | Rp 21.800/ pcs   | Rp 21.800          |
| Dust Bag                                | 1                         | Rp 19.000/ pcs   | Rp 19.000          |
| Stainless steel<br>broom handle         | 100 cm                    | Rp 35.000/ 150cm | Rp 23.333 (100 cm) |
|                                         | 30 cm                     |                  | Rp 7.000 (30 cm)   |
| Gear wheel                              | 2                         | Rp 5.000/ pcs    | Rp 10.000 (2 pcs)  |
| Rubber corner<br>protectors             | 4                         | Rp 1.500/ pcs    | Rp 6.000 (4 pcs)   |
| Plastic body                            | (33 cm x 16 cm x 5<br>cm) | Rp 9.767         | Rp 9.767           |
| Wheels (1 inch<br>diameter)             | 2                         | Rp 4.750/ pcs    | Rp 9.500 (2 pcs)   |
| Total                                   |                           |                  | Rp 167.186         |

The raw material pricing plan is based on the lowest average market price, yet maintains high quality. This allows for lower total raw material costs, ensuring they remain affordable for consumers (Sasoko & Mahrudi, 2023). These raw material prices are based on market research on the online shopping platforms Shopee and Tokopedia.

#### *b) Product Selling Price*

The product's selling price is based on the total cost of raw materials plus a profit margin. The profit margin is 15%, or Rp 25.077. Therefore, the resulting selling price is Rp 167.186 + Rp 25.077 or Rp 192.263.

#### *c) Product Design*

The product design is based on product design and competitive product benchmarking analysis. This product design serves as an overview and reference for the development of

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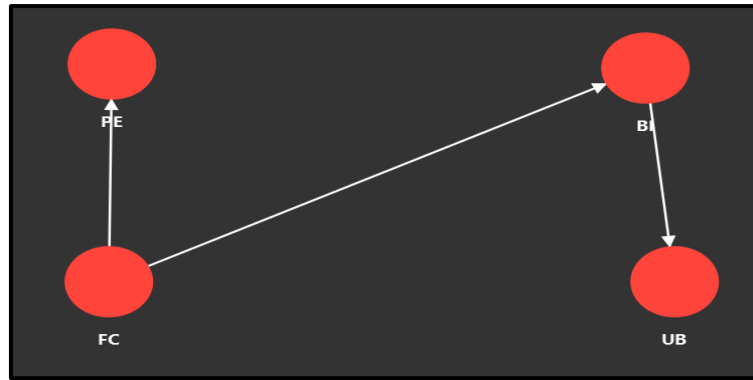


By applying the public acceptance model, we can determine how potential customers respond to the design innovation. The UTAUT method was implemented by distributing questionnaires to 30 respondents identified as potential users of the designed tool. Based on the validity test, all statements were valid because the calculated R value was greater than the table R value. Meanwhile, the reliability test results indicated that the research instrument was reliable and consistent, and the data could be used for further processing. This was based on a Cronbach's alpha value of  $0.64131 \geq 0.60$ .

H1: Consumer facilitating conditions influence the performance expectancy of the designed tool.

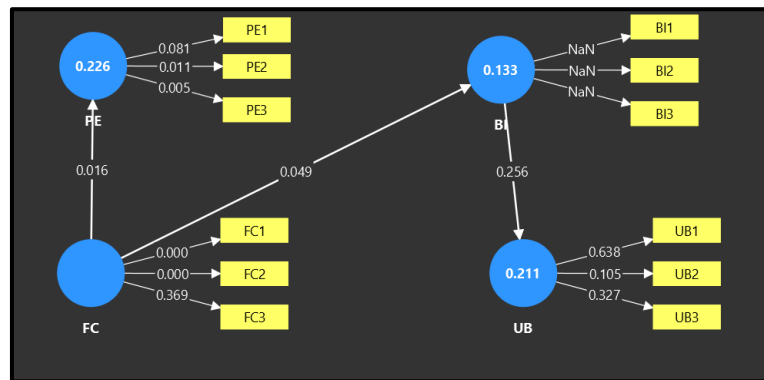
H2: Consumer facilitating conditions influence behavioral intention to use the designed tool.

H3: Behavioral intention influences user behavior after using the designed tool.



**Figure 5.** UTAUT 4-Indicator Relationship Model

After data processing using SmartPLS 4 software, the following outer model and correct hypothesis were obtained:



**Figure 6.** Outer Model

**Table 6.** Values of the Relationship Between UTAUT Indicators

| Indicators | T Statistic | P Values |
|------------|-------------|----------|
| BI => UB   | 1.135       | 0.256    |
| FC => BI   | 1.972       | 0.049    |
| FC => PE   | 2.403       | 0.016    |

The table shows that Hypotheses 2 and 3 have T-statistics greater than the specified Z-value of 1.96, and P-values less than 0.5 (Mulyawan et al., 2025). This indicates a significant influence between the indicator variables. This also means that Hypothesis 1 is rejected and Hypotheses 2 and 3 are accepted.

## Conclusion

Based on the results of the needs analysis, problem mapping, and design process, it can be concluded that the Cen Craft community requires a cleaning tool that can improve work efficiency in collecting small waste and remaining recyclable materials. The Automatic Garbage Picker Tool is designed as the perfect solution because it utilizes a mechanical, non-electrical rotating wheel and brush system, making it energy-efficient, easy to operate, ergonomic, and suitable for small-scale community environments. This tool has the potential to reduce work fatigue, speed up the cleaning process in production areas, and increase community productivity. Furthermore, the use of strong materials and competitive selling price offer opportunities for wider marketing, making this tool potentially suitable for sustainable use in other recycling communities.

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