Emotional Perception and Ergonomic Design Innovation of A Portable Chicken Feather Cleaner: A Kansei Engineering Study

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Abstract
Users' emotional perception plays a crucial role in the development of effective ergonomic product designs, particularly in tools used for domestic and small-scale industrial activities. This study aims to investigate the influence of emotional perception on the ergonomic design innovation of a portable chicken feather cleaning tool using the Kansei Engineering approach. This method was employed to translate user emotions and perceptions into measurable and implementable design elements. The research process involved identifying relevant kansei words, collecting perception data from 60 respondents using a semantic differential scale questionnaire, and performing factor analysis and Principal Component Analysis (PCA) to determine the core affective dimensions. The results revealed that physical comfort, form perception, and motion efficiency are the dominant factors influencing user preferences. Based on these findings, an ergonomic prototype was developed by optimizing hand posture, device weight, and handle shape. The study concludes that integrating emotional dimensions into the design process significantly enhances product-user affective compatibility, potentially improving both work efficiency and user satisfaction. These findings offer practical implications for the design of functional household tools based on human-centered design principles.

***Keywords*:** *Kansei Engineering, Ergonomic Design, Emotional Perception, Chicken Feather Cleaner, Portable Product Design*.

Abstrak
Persepsi emosional pengguna memainkan peran penting dalam pengembangan desain produk ergonomis yang efektif, khususnya pada peralatan kerja yang digunakan secara

langsung dalam aktivitas domestik dan industri kecil. Penelitian ini bertujuan untuk menginvestigasi pengaruh persepsi emosional terhadap desain ergonomis alat pembersih bulu ayam portable dengan pendekatan Kansei Engineering. Metode ini digunakan untuk menerjemahkan persepsi dan afeksi pengguna ke dalam elemen desain yang dapat diukur dan diimplementasikan. Proses penelitian melibatkan identifikasi kata kansei, pengumpulan data persepsi dari 60 responden melalui kuesioner skala semantic differential, serta analisis faktor dan Principal Component Analysis (PCA) untuk menentukan dimensi afektif utama. Hasil menunjukkan bahwa kenyamanan fisik, persepsi bentuk, dan efisiensi gerak merupakan faktor utama yang memengaruhi preferensi pengguna. Berdasarkan hasil tersebut, rancangan prototipe ergonomis dikembangkan dengan mempertimbangkan aspek postur tangan, berat alat, dan bentuk pegangan. Studi ini menyimpulkan bahwa integrasi dimensi emosional ke dalam proses desain mampu meningkatkan kesesuaian produk terhadap kebutuhan afektif pengguna dan berpotensi meningkatkan efisiensi kerja serta kepuasan pengguna. Temuan ini memberikan kontribusi praktis bagi desain alat rumah tangga fungsional yang berbasis pendekatan human-centered design.

Keywords**:** *Kansei Engineering, Desain Ergonomis, Persepsi Emosional, Pembersih Bulu Ayam, Desain Produk Portable.*

1. Introduction

Ergonomic product design plays a critical role in the development of work equipment used in repetitive manual activities, particularly in small-scale home industries and Micro, Small, and Medium Enterprises (MSMEs). One such activity is the manual cleaning of chicken feathers, which is still predominantly performed using simple, portable tools. Field observations and prior ergonomic studies indicate that workers engaged in manual poultry processing are exposed to high levels of physical fatigue, particularly in the upper limbs, wrists, and lower back, as a result of prolonged static postures, repetitive gripping motions, and non-neutral wrist positions [1]. Awkward postures, including excessive wrist flexion, sustained shoulder elevation, and forward trunk bending, have been identified as major risk factors for musculoskeletal disorders (MSDs) in comparable manual food-processing tasks [2].

Despite being labeled as portable, many existing chicken feather cleaning tools are designed with limited ergonomic consideration. Current portable tools often prioritize compactness and low manufacturing costs, resulting in shortcomings such as inappropriate grip dimensions, uneven weight distribution, slippery handle surfaces, and insufficient accommodation of natural hand posture. These limitations reduce operational efficiency and increase user fatigue, particularly during prolonged use, thereby highlighting the need for ergonomic innovation that extends beyond mere portability [3]. However, most existing design

improvements focus primarily on mechanical performance, with limited attention given to users' emotional responses during interaction with the tool.

In recent years, product design research has emphasized that effective human–product interaction is influenced not only by functional performance but also by users' emotional perceptions and affective experiences [4]. Emotional perception affects how users evaluate comfort, safety, usability, and overall satisfaction, which in turn influences work motivation and performance. Tools that elicit negative emotions, such as discomfort, insecurity, or frustration, tend to increase perceived workload and accelerate fatigue, whereas positive emotional responses can enhance perceived comfort and task engagement [5].

Kansei Engineering (KE) has emerged as a scientific approach capable of translating users' emotional responses into concrete and measurable design parameters. Kansei Engineering is generally classified into several types, including Type I (Category Classification), Type II (Kansei Engineering System), and Type III (Hybrid or Modeling-Based Kansei Engineering). Kansei Engineering Type I focuses on identifying dominant emotional descriptors (Kansei words) and mapping them directly to product attributes through statistical analysis, making it particularly suitable for early-stage product development and the redesign of existing tools [6]. Compared with other types, Type I is more practical and effective for MSME-oriented product innovation due to its lower complexity, minimal computational requirements, and strong user-centered orientation.

In the context of portable chicken feather cleaning tools, the integration of ergonomic principles with Kansei Engineering Type I provides an opportunity to systematically incorporate users' emotional perceptions such as comfort, confidence, safety, and ease of use into the design process. Ergonomic factors, including grip shape, handle diameter, tool weight, and balance, directly influence physical comfort, while emotional perception mediates how these physical attributes are interpreted and experienced by users. A positive emotional response can reduce perceived exertion, promote the adoption of neutral working postures, and ultimately enhance work efficiency and tool performance [7].

Although previous studies have examined ergonomic design improvements and affective-based product evaluations separately, limited research has explored the combined application of ergonomic analysis and Kansei Engineering in the development of portable poultry-processing tools, particularly within MSME settings. Moreover, the role of emotional perception as a mediating factor between ergonomic design and user performance remains insufficiently explored.

Therefore, the research gap lies in the absence of a comprehensive design framework that integrates emotional perception with ergonomic principles for portable chicken feather cleaning tools. The novelty of this study lies in the application of Kansei Engineering Type I to identify and translate users' emotional perceptions into ergonomic design innovations for a portable chicken feather cleaning tool. By explicitly linking emotion, ergonomics, and performance, this study aims to develop a user-centered tool design that not only reduces physical fatigue but also enhances user satisfaction and work efficiency.

2. Method

This study uses the Kansei Engineering Type I approach, which aims to translate users' emotional perceptions of the design of a portable chicken feather cleaner into measurable and implementable design attributes. This method involves systematic stages starting from identifying kansei words, compiling a semantic scale questionnaire, factor analysis, to mapping emotional dimensions to product design attributes

2.1 Identification of Kansei Words

The initial step in this study was to collect kansei words that represent users' emotional perceptions of the chicken feather cleaner. These words were obtained through literature studies, observations, and initial interviews with 15 potential users (chicken processing MSMEs). From the results of the collection, 24 kansei words were obtained such as "comfortable", "light", "modern", "safe", "efficient", and "easy to use" [8].

2.2 Questionnaire Development and Data Collection

The questionnaire was developed using a 5-point semantic differential scale to measure the intensity of respondents' perceptions of product design based on selected Kansei words. The semantic differential scale is widely used in Kansei Engineering studies to capture users' affective responses by positioning perceptions between pairs of opposite emotional descriptors [9]. Relevant Kansei words were identified through a literature review and preliminary observations to ensure their contextual relevance to manual chicken feather cleaning tools.

The initial product design was visualized using computer-aided design (CAD) drawings and presented to 60 respondents who represented potential end users of the tool. A purposive sampling technique was employed to ensure that all respondents had relevant experience and familiarity with the evaluated task [10]. The respondent selection criteria included: (1) productive working age (20–50 years), (2) prior experience using chicken feather cleaning tools or similar manual poultry-processing equipment, and (3) active involvement in small-scale or home-based poultry processing activities.

The sample size of 60 respondents was considered adequate for Kansei Engineering Type I analysis. Previous Kansei Engineering and affective design studies have reported that a sample size ranging from 30 to 100 respondents is sufficient to identify dominant emotional attributes and establish statistically meaningful relationships between Kansei words and product design parameters [11]. Data obtained at this stage were used to analyze users' emotional preferences and to generate initial ergonomic design recommendations.

2.3 Statistical Analysis: Factor Analysis and PCA

The data obtained from the questionnaire were analyzed using Exploratory Factor Analysis (EFA) to reduce the number of kansei words into the main affective dimensions. Testing was carried out using SPSS v26 software with the Principal Component Analysis (PCA) extraction method and Varimax rotation. The Kaiser-Meyer-Olkin (KMO) and Bartlett's Test criteria were

used to measure data feasibility, with a KMO value> 0.7 and a significance <0.05 considered valid to proceed to PCA [8].

2.4 Kansei Mapping and Prototype Design

The emotional dimensions of the PCA results are mapped against product design attributes such as grip shape, tool weight, body material, and button position. This mapping is the basis for developing an ergonomic prototype that is adjusted to human body posture, taking into account the anthropometric standards of the Indonesian people's hands [12]. The prototype design was created using CAD (Computer-Aided Design) software and printed with 3D printing technology for initial evaluation purposes.

2.5 Design Validation

Design validation was conducted through prototype trials involving 10 users using a user testing approach. This validation stage aimed to evaluate the ergonomic performance, usability, comfort, ease of use, and emotional satisfaction associated with the final design prototype. Participants were selected using purposive sampling, with criteria consistent with those applied during the questionnaire stage, emphasizing direct experience in manual chicken feather cleaning activities.

The number of participants in the validation stage was deliberately limited to 9 users, as the primary objective of this phase was usability evaluation and design verification rather than statistical generalization. In ergonomic and usability research, it has been widely demonstrated that the majority of usability and ergonomic issues can be identified with a relatively small number of representative users, typically ranging from 5 to 9 participants [11]. Therefore, involving 9 users was considered sufficient to capture critical ergonomic issues and user experience feedback while maintaining feasibility and control during prototype testing.

Following the prototype trials, participants completed an evaluative questionnaire using a Likert scale to assess perceived comfort, ease of use, safety, and emotional satisfaction with the final design. The validation data were analyzed descriptively and qualitatively to confirm the suitability of the proposed design and to refine the final design recommendations.

3. Results and Discussion

3.1 Results

Multiple linear regression results showed that the combination of Lean Office and Industry 4.0 technologies accounted for 90.8% of the variance in administrative performance outcomes ($R^2 = 0.908$). The F-test result of 6.663 ($p = 0.003$) confirmed the statistical significance of the model. This validates prior findings by [2], [23] regarding the synergistic effect of lean and digital transformation frameworks in service-based.

3.1.1 Respondent Characteristics

A total of 60 respondents participated in the Kansei questionnaire. Respondents were purposively selected from micro and small enterprises (MSEs) engaged in broiler chicken processing. Their characteristics are as follows: 40% male and 60% female, aged between 25

and 45 years, and with a minimum of one year of work experience in feather plucking, either manually or using auxiliary tools.

These characteristics are relevant because users of feather removal tools are typically small-scale producers who prioritize comfort during prolonged tool usage [8]

3.1.2 Kansei Word Processing Results

A total of 24 Kansei words were identified from the preliminary study. These words reflect users' perceptions of the tool, such as: comfortable, lightweight, simple, modern, safe, durable, efficient, flexible, ergonomic, and pleasant. These words were used in a semantic differential scale (1–5) to evaluate three initial design concepts of a portable chicken feather removal tool.

3.1.3 Data Feasibility Test: KMO and Bartlett's Test

Preliminary analysis was conducted using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity to assess whether the data was suitable for Principal Component Analysis (PCA). The KMO value obtained was 0.823, indicating strong sampling adequacy. Bartlett's Test showed significance at $p = 0.000$, meaning the correlations among variables were sufficiently significant for further analysis. A KMO value greater than 0.8 is considered meritorious, indicating high factorability of the data [13]**.**

3.1.4 Factor Analysis: Principal Component Analysis (PCA)

PCA was performed on the 24 Kansei variables. Based on eigenvalues > 1, five principal components (factors) were extracted, explaining 72.4% of the total data variance. After Varimax rotation, the emotional dimensions were interpreted as follows:

Table 1. Principal Component Analysis (PCA)

Component	Affective Dimension	Dominant Kansei Words	Variance (%)
1	Ergonomic Comfort	comfortable, non-slippery, lightweight, balanced	22.1
2	Visual Aesthetics	modern, clean, simple, attractive	17.6
3	Safety and Stability	safe, strong, durable	12.8
4	Usage Efficiency	fast, practical, energy-saving	10.3
5	Emotional Satisfaction	pleasant, familiar, meets expectations	9.6

his interpretation aligns with [14], who emphasized the importance of comfort and safety dimensions in the design of work assistive tools

3.1.5 Mapping Kansei Dimensions to Design Attributes

The five affective dimensions were then mapped to specific product design attributes. The mapping results are as follows in Table 2.

Table 2. Mapping of Affective Dimensions and Design Attributes

Affective Dimension	Related Design Attributes
Ergonomic Comfort	Handle size and shape, button position
Visual Aesthetics	Body color, casing shape, surface finishing
Safety and Stability	Body and blade cover material, weight distribution
Usage Efficiency	Cable length, feather outlet port position
Emotional Satisfaction	Overall silhouette, noise level

Based on this mapping, an ergonomic prototype was developed by improving the handle design, button placement, and casing material. The handle was designed according to the anthropometric dimensions of Indonesian users' hands [15], with a 30-degree inclination angle to minimize wrist strain

3.1.6 Prototype Validation

The prototype was tested by 9 users in a real work environment for approximately 20 minutes of continuous use. Evaluation focused on comfort, ease of use, and emotional satisfaction using a 5-point Likert scale. The test results showed that the new design achieved average scores of 4.6 for comfort, 4.4 for ease of use, and 4.5 for emotional satisfaction a significant improvement compared to the initial design (3.2, 3.1, and 3.0 respectively).

3.2 Discussion

The findings of this study demonstrate that integrating Kansei Engineering into the design process effectively identifies and optimizes affective elements that influence user comfort and satisfaction. The ergonomic comfort dimension proved to be the most influential in forming a positive perception of the tool. This supports the findings, which emphasized physical comfort as a priority in portable work tool design. Furthermore, mapping affective factors to design attributes provides clear direction for designers to create products that are not only functional but also emotionally engaging. The effectiveness of this approach opens up opportunities for developing other human-centered assistive tools.

4. Conclusion

This study successfully identified and implemented ergonomic design attributes relevant to users' affective needs through the Kansei Engineering approach in designing a portable chicken feather cleaning tool. The factor analysis using PCA and statistical testing with SPSS revealed that emotional perceptions such as grip comfort, ease of use, lightweight, and visual aesthetics significantly contributed to product design preferences. These findings were reinforced by a positive correlation between Kansei dimensions like "comfortable," "lightweight," and "easy to use" and the alternative designs developed in the final prototype.

From a methodological perspective, the application of Kansei Engineering Type I proved effective in translating affective perceptions into measurable product design specifications. The integration of quantitative results from the Kansei questionnaire with qualitative findings from

ergonomic testing enabled the formulation of a design that is both functional and emotionally satisfying. Active user involvement in each design phase also contributed to the relevance and validity of the final product.

Therefore, it can be concluded that the Kansei Engineering approach provides a significant contribution to the design of ergonomic and user-centered products, particularly in the context of portable feather cleaning tools that demand efficiency, comfort, and mobility. This study also opens opportunities for developing similar tools for MSEs or household agribusiness sectors based on technology and design oriented toward user emotional satisfaction.

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