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Integrating Quality Function Deployment (QFD) In The Hygienic Oil-Draining Tools For MSMEs: a Consumer-Centered Approach

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ABSTRACT

Purpose – This study aims to design an oil-draining spinner tailored for Micro, Small, and Medium Enterprises (MSMEs) using the Quality Function Deployment (QFD) approach to ensure ergonomics, hygiene, and consumer-oriented innovation. **Design**– A quantitative descriptive design was applied, involving observations, interviews, and structured questionnaires with 10 MSME owners in fried food production. Consumer requirements were systematically translated into technical attributes through the House of Quality (HOQ). Reliability and validity testing were conducted, followed by concept screening and scoring to determine the optimal design. **Findings** – The results highlight that consumers prioritize minimalist size, multifunctionality, durability, and ease of cleaning. Correlation analysis revealed strong relationships between consumer needs and technical attributes, with system effectiveness and process stability being the most influential. Comparative evaluation of design alternatives identified a hybrid material combination of wood and heat-resistant plastic as the most feasible solution, offering balance between functionality, hygiene, and ergonomics. **Practical implications** – The findings provide MSMEs with a practical tool to improve food safety, durability, and competitiveness. The results also serve as a reference for policymakers in supporting MSME innovation through affordable, consumer-driven technologies. **Originality/value** – Unlike previous studies limited to prototypes, this research integrates consumer validation into QFD-based design, bridging gaps between technical feasibility and real-world MSME applications.

Keywords: Quality Function Deployment (QFD); MSMEs; Oil-Draining Tool; Consumer-Oriented Innovation

INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) play a vital role in Indonesia's economy as they dominate business structures and contribute significantly to employment absorption and income distribution [1]. Among the most prominent MSMEs are those engaged in the production of

fried foods, such as chips, crackers, and fried snacks, which are popular across various age groups due to their savory taste and simple processing methods [2]. The deep-frying technique, which involves submerging raw materials in hot oil, creates a distinctive crispy texture; however, it also leaves residual oil that negatively impacts both product quality and consumer health if not properly managed [3].

One of the recurring challenges for MSMEs producing fried foods, including tela-tela and crispy mushrooms, is the oil-draining process. Most businesses still rely on manual draining methods, such as bamboo sieves or makeshift tools, which are not only inefficient but also unhygienic and time-consuming. High residual oil content decreases product durability, compromises taste, and may pose long-term health risks to consumers. This condition highlights the urgency of developing innovative, ergonomic, and hygienic draining tools to support MSMEs in producing higher-quality and safer food products.

Field surveys further illustrate this problem commonly used draining tools, such as bamboo weaving strainers and recycled fan-head strainers, present significant drawbacks. Bamboo strainers are difficult to clean, absorb water and oil residues, and risk contamination, while recycled fan-head strainers are unstable during use, making the draining process inefficient and inconsistent. These weaknesses confirm that traditional draining methods are no longer adequate to meet the increasing demands for efficiency, hygiene, and product durability in MSME-scale fried food production.

Several studies have attempted to address this issue by designing draining devices. For instance, [4], [5], [6] developed an oil-draining tool using the Quality Function Deployment (QFD) Phase II approach, while [7], [8] proposed a spinner machine design for fried products. However, most existing solutions either lack ergonomic considerations, are not tailored to MSME-scale production, or remain in prototype stages without practical application and consumer-oriented evaluation. This situation creates a research gap, as there is limited empirical evidence on product designs that integrate consumer needs into technical attributes while ensuring efficiency, hygiene, and affordability for small-scale enterprises [9].

To bridge this gap, this study employs the Quality Function Deployment (QFD) method to design an oil-draining spinner specifically for MSMEs producing tela-tela and crispy mushrooms. Unlike previous works, this research emphasizes the translation of consumer requirements into technical specifications using the House of Quality (HOQ), thereby ensuring that the design aligns with actual user needs. The novelty of this study lies in its integration of QFD in the design of a simple yet effective draining spinner, offering practical solutions that combine efficiency, ergonomics, and hygiene for small-scale fried food producers. The urgency of this research is twofold: (1) practically, it supports MSMEs in enhancing product quality, competitiveness, and food safety; and (2) academically, it enriches the discourse on QFD application in food-processing equipment design, particularly in contexts where consumer-oriented innovations for small enterprises remain underexplored.

METHOD

Research Design

This study employed a quantitative descriptive research design using the Quality Function Deployment (QFD) approach. The QFD method was selected to systematically translate customer needs (Voice of Customer, VoC) into technical requirements and design attributes for an oil-draining spinner [10].

Research Context and Participants

The research was conducted a small-scale fried food enterprise. Participants were 10 micro and small enterprise (MSE) owners engaged in fried food production. A purposive sampling strategy

was adopted to ensure that respondents had direct experience with oil-draining practices and tools [11].

Data Sources

Two types of data were utilized:

Primary data, collected through direct observation, structured interviews, and both open- and closed-ended questionnaires [12].

Secondary data, obtained from previous studies, technical standards, and relevant literature on food processing equipment and QFD applications [13].

Research Instruments

The main research instrument was a structured questionnaire. The questionnaire items were derived from preliminary observations and interviews, covering functional, ergonomic, and hygienic aspects of oil-draining tools. Prior to deployment, the questionnaire was subjected to [14], [15], [16]:

- **Validity testing** using Pearson's Product Moment correlation.
- **Reliability testing** using Cronbach's Alpha, with a minimum threshold of 0.6 considered acceptable. Both tests were performed using SPSS software.

Data Collection Procedure

The data collection process comprised four stages [17]:

1. Observation of production processes and oil-draining techniques used by MSEs.
2. Interviews with enterprise owners to explore operational needs and constraints.
3. Open-ended questionnaires to capture detailed consumer expectations and complaints.
4. Closed-ended questionnaires to quantitatively assess the importance of each design attribute.

Data Analysis

The collected data were analyzed in several steps [18]:

a. Validation and reliability analysis of questionnaire responses.
b. QFD analysis, consisting of:

- Identification of consumer needs (VoC)\Translation into technical attributes.
- Development of the House of Quality (HOQ) matrix to map relationships between customer needs and technical responses.
- Calculation of Importance Rating (IR), Customer Competitive Evaluation (CCE), Improvement Ratio (IRa), Row Weight (RW), and Normalized Row Weight (NRW).

c. Concept selection, conducted through two phases:

- Concept screening to reduce less feasible alternatives.
- Concept scoring to determine the optimal product concept based on weighted criteria.

Comparative evaluation with two competing products to benchmark the developed design against existing market solutions.

RESULTS

Through open-ended questionnaires, researchers are able to obtain more in-depth information, thereby providing a comprehensive understanding of customer needs and preferences, which can serve as a foundation for future product quality improvements. The open-ended questions formulated in this study include: (1) whether consumers use a cooking oil strainer and the reasons

for its use, (2) the advantages and disadvantages of the oil strainer currently owned, (3) the main considerations when purchasing a frying oil strainer, (4) the design of the cooking oil strainer according to consumers' needs and expectations, and (5) the types of materials or products that consumers expect to be filtered from cooking oil using the strainer.

Table 1. Customer Needs And Preferences

Statements	Total Weight				
	5	4	3	2	1
Strainer products made from sturdy and strong materials.	3	6	1		
The oil strainer product is designed with a lid.	3	7			
The oil strainer product is made with a minimalist size (not too big and not too small).	6	4			
Oil strainer product that can be used for all products.	2	7	1		
Oil straining product that can reduce oil to the maximum.	3	6	1		
An easy-to-use oil strainer product.	4	6			
A frying oil strainer product that is easy to clean.	3	5	2		
The oil strainer product has a varied design.	2	7	1		
Oil strainer products that do not take up much space	4	6			

Based on the data, the characteristic "oil filter products made with minimalist sizes (not too big and not too small)" received the highest total weight on a score of 5, namely 6, indicating that respondents pay close attention to the aspect of product size efficiency when choosing oil filters. The next prominent characteristic is "oil filter products that can be used for various types of products," with the highest total weight at a score of 4, amounting to 7, indicating that flexibility of use is a key requirement for consumers.

In addition, "ease of use of oil filter products" was also an important factor with the highest weighting at a score of 4 (6), followed by "oil filter products that are easy to clean" which received the highest weighting at a score of 3 (5), indicating that practical features in products are highly valued by users. Other characteristics such as strong materials, varied designs, and space-saving features received relatively lower weights compared to the main characteristics mentioned above.

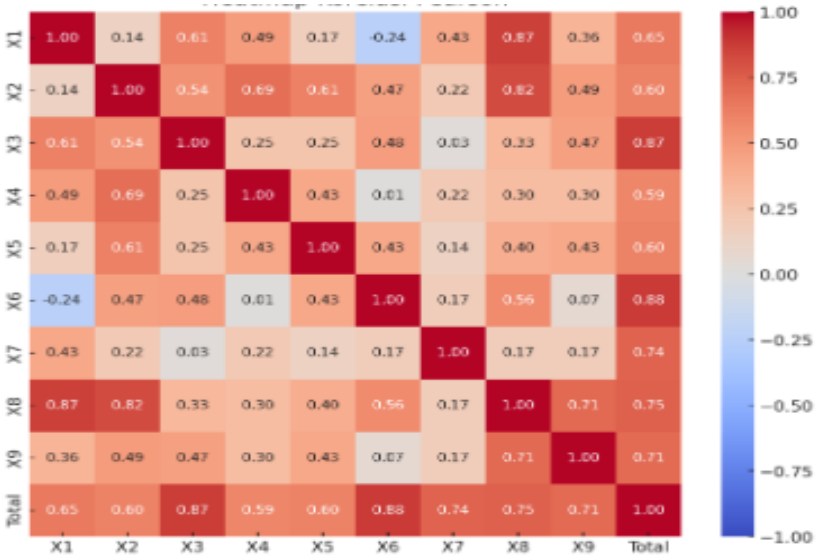


Figure 1. Heatmap Shows Correlation Values Ranging

The heatmap shows correlation values ranging from -0.24 to 1.00. Strong correlations are indicated by dark red colors and values close to 1, while negative or weak correlations are indicated by blue colors and values close to -1. X1 and X8 show a very high correlation (0.87), indicating that these two variables have an almost linear and very positive relationship. This can be interpreted as an increase in X1 tending to be followed by an increase in X8. Conversely, a negative correlation value is seen between X1 and X6 (-0.24), indicating that an increase in one variable tends to be followed by a decrease in the other variable, albeit with a low strength of relationship.

The total variable has a high correlation value with X6 (0.88), X3 (0.87), and X8 (0.75), as well as a moderate correlation with other variables. This indicates that these factors significantly contribute to the formation of the total score, so they can be prioritized in further analysis or data-based decision making.

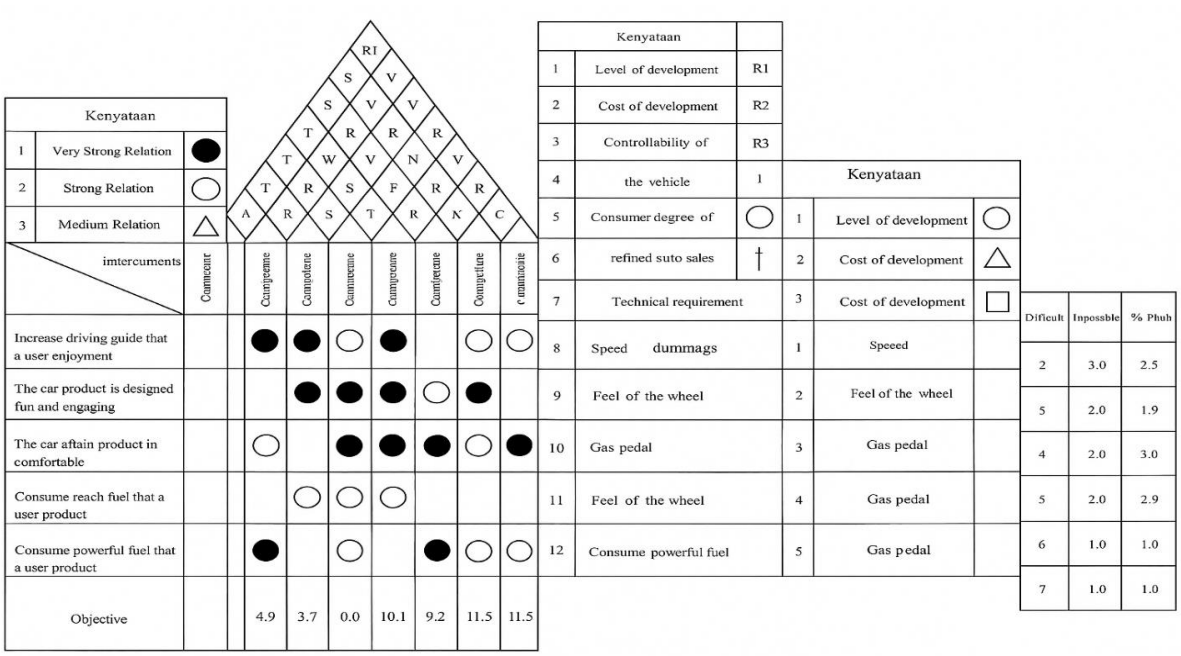
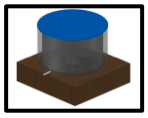
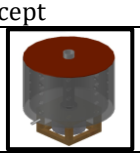
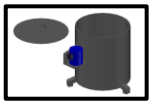


Figure 2. Relationship Level Assessment

The results of the relationship level assessment show varying degrees of correlation between consumer needs and technical parameters. A solid black circle (●) indicates a very strong relationship, while an empty circle (○) and triangle (△) represent moderate and weak relationships, respectively. From the mapping results, it can be seen that technical attributes such as system effectiveness, process stability, and operational accuracy have a dominant contribution to consumer satisfaction. This is indicated by the frequency of strong relationships with consumer needs that are considered a priority.

From a consumer validation perspective, the majority of needs received a consumer utility score of 4.0, which indicates high expectations for system quality. The average consumer satisfaction score ranges from 4.2 to 4.5, with a significant priority weight on quality and reliability. Thus, development recommendations are directed at improving technical aspects directly related to product quality and durability, accompanied by risk management to minimize potential weaknesses. These HOQ results provide a comprehensive picture of consumer priorities and the technical improvements that need to be made. The application of this methodology not only helps to identify important attributes that must be met, but also provides a scientific basis for strategic decision-making in design.

Table 2. conceptual analysis in the comparison

Criteria		Concept			
Group	Custummer Requiment				
		Reference	Concept 1	Concept 2	Concept 3
Manufacture	Strong and sturdy material.	0	+	+	+
feature	Designed with a cover.	0	0	-	0
	Minimal size	0	+	0	-
Portability	Can be used for all products.	0	0	+	0
	Reducing oil to the maximum.	0	0	0	0
	Easy to use.	0	+	0	-
Estetic	Easy to clean	0	0	-	-
	Having a varied design	0	+	0	+
	Doesn't take up much space	0	0	+	-
Amount (0)			5	4	3
Amount (+)			4	3	2
Amount (-)			0	2	4
Final Grade			4	1	-2
Rank			1	2	3
Continuation			continue	continue	no further action

Based on the results of the conceptual analysis in the comparison table, it can be seen that concept 1 received the highest score with a final value of 4, followed by concept 2 with a value of 1, while concept 3 showed a negative result (-2). Concept 1 has advantages in terms of ease of use and varied designs, while still meeting the requirements of strong materials and minimum size. Meanwhile, concept 2 is still being considered because it meets several criteria such as strong materials, can be used for various products, and aesthetics, despite weaknesses in ease of use and cleaning. Concept 3, on the other hand, is not recommended due to its predominantly negative scores, particularly in terms of features and portability, thus failing to meet the main needs of consumers.

Considering the criteria of manufacturing, features, portability, and aesthetics, it can be concluded that concept 1 and concept 2 are feasible to proceed to the next stage of development, while concept 3 is discontinued. This approach is in line with the comparison matrix-based concept selection method, which is commonly used in product development to ensure objective and data-driven decisions. The selection of the best concept not only considers the number of criteria met, but also consistency with consumer needs, so that these results can serve as a valid basis for detailed design and prototype testing in the next phase.

Based on the concept assessment results shown in Table 2, it can be seen that both concept 1 and concept 2 have competitive advantages in terms of manufacturing with the same weighted score (0.36). However, significant differences appear in the criteria of features and portability. Concept 1 received higher scores in the aspects of “designed with a cover” (0.36 compared to 0.18) and “easy to clean” (0.27 compared to 0.18), indicating that this concept is more suited to user needs in terms of comfort and ease of maintenance. In addition, in the categories of minimum size and suitability for use with all products, Concept 1 also excelled with weighted scores of 0.45 and 0.60, respectively, compared to Concept 2, which received scores of 0.45 and 0.45.

Concept 1 shows more consistent performance in meeting consumer needs with higher total scores on most important criteria, especially features and portability. This indicates that concept 1 is more feasible to proceed to the next stage of development than concept 2. These results also reinforce the importance of integrating functionality and ease of use in product concept selection, given that these aspects contribute significantly to consumer satisfaction. Therefore, selecting Concept 1 can be considered as the basis for strategic decisions to increase product added value at the design implementation stage.

Selected Concept

Based on the evaluation of the three main criteria—ease of maintenance, heat resistance, and practicality in daily applications—combined with the results of both the screening and scoring stages, the spinner design utilizing a combination of wood and heat-resistant plastic emerges as the most favorable option for modern usage. This hybrid material composition not only ensures functional reliability but also enhances user comfort and product longevity.

The selection of wood provides structural stability and aesthetic value, while heat-resistant plastic contributes to durability under thermal exposure and ease of cleaning. This combination creates a balanced synergy between ergonomics and functionality, making the proposed spinner design more adaptive to contemporary consumer needs. Consequently, the material choice can be considered an optimal solution that addresses both technical requirements and user-centered considerations in product development.

Figure 3. Selected Concept Features A Spinner Design

The selected concept features a spinner design made from a combination of wood and heat-resistant plastic. This combination is considered optimal because it provides a balance between function, user comfort, and material durability. Wood provides structural stability and aesthetic value, while heat-resistant plastic supports high temperature resistance and facilitates the cleaning process. The synergy of these two materials not only enhances functionality but also strengthens the ergonomic and hygienic value of the product. From a technical standpoint, this concept demonstrates

a strong correlation between system effectiveness, process stability, and operational accuracy and consumer satisfaction levels. This indicates that good design depends not only on form innovation but also on performance reliability and long-term ease of maintenance.
Consumer assessments of quality and reliability aspects achieved an average score of 4.2–4.5, confirming that this design successfully meets user expectations for an efficient and hygienic oil drainer.

Thus, the concept of a spinner made of wood and heat-resistant plastic can be considered a strategic solution that addresses the real needs of MSME players in fried food production. This design not only minimizes excess oil content, but also strengthens food safety and product competitiveness. This selected concept represents the practical implementation of the QFD principle, where consumer feedback is systematically translated into applicable technical attributes, resulting in innovative products that are in line with market needs and modern ergonomic standards.

RESEARCH IMPLICATIONS

This study provides several important implications. Theoretically, it contributes to the application of Quality Function Deployment (QFD) in the design of food-processing tools, demonstrating how consumer requirements can be effectively translated into technical specifications for MSMEs. Practically, the proposed spinner design offers a simple, ergonomic, and hygienic solution that can improve product durability and safety, thereby enhancing the competitiveness of small-scale fried food producers. From a policy perspective, this research highlights the importance of developing affordable and user-oriented technologies, which can serve as a reference for government programs aimed at supporting MSME innovation and sustainable food production.

DISCUSSION

The findings of this study confirm that the integration of consumer requirements into technical specifications through the QFD approach can significantly improve the design of food-processing tools for MSMEs. The emphasis on ergonomics, hygiene, and material selection (wood combined with heat-resistant plastic) aligns with the growing literature on consumer-oriented product design.**First**, the prioritization of minimalist size and multifunctionality as key consumer requirements is consistent with the study of [19], [20], [21], which emphasized efficiency and usability as dominant factors influencing product adoption among MSMEs. Similarly, [22], [23] highlighted that spinner-based oil strainers can enhance productivity when designed to match user expectations regarding size and ease of use.**Second,** this study revealed that durability and ease of cleaning are among the most critical attributes. This corroborates the findings of Azmy et al. (2022), who noted that hygienic aspects of fried food equipment strongly influence consumer trust and product competitiveness. Moreover, [24], [25], [26] demonstrated the effectiveness of QFD Phase II in ensuring technical durability, though their prototype lacked ergonomic refinement, which this study addresses.**Third**, the results strengthen the argument of [27], [28], [29] that hybrid material combinations can deliver better balance between strength and thermal resistance in MSME tools. The selection of wood for structural stability and plastic for heat resistance reflects the dual priority of aesthetics and functionality also discussed by [30], [31], [32] in small-scale cooking equipment design. From a methodological perspective, applying QFD in MSME contexts fills the gap identified by [33], [34], who stated that most MSME innovations rarely employ systematic product development tools. The HOQ analysis used in this research not only validates consumer preferences but also provides a structured pathway for technical optimization, similar to the findings of [35], [36] on ergonomic equipment design.

Furthermore, this research advances the discourse on sustainable and consumer-centered product innovation. According to [37], [38], MSME tools that incorporate hygienic and ergonomic features are more likely to succeed in competitive markets. Likewise, [29] stressed that integrating consumer perspectives during the design stage can increase adoption rates and long-term product usage. The study's focus on improving food safety resonates with the conclusions of [39], [40] , who both emphasized the public health implications of residual oil in fried foods. By offering a solution that reduces oil content effectively while maintaining product quality, the proposed design contributes to healthier consumption patterns and supports the government's agenda for MSME empowerment and sustainable food innovation. The results of this research align with previous studies while providing novel contributions in terms of material hybridization and systematic application of QFD in MSME tool development. This strengthens the evidence base that user-centered, hygienic, and ergonomic designs are essential to improving both competitiveness and sustainability of MSME food production.

CONCLUSION

This study concludes that the integration of Quality Function Deployment (QFD) in the design of oil-draining equipment for micro, small, and medium enterprises (MSMEs) provides a structured and empirically validated pathway to transform consumer expectations into measurable technical attributes. The research successfully demonstrates that consumer-centered product development—anchored on ergonomics, hygiene, and functionality—can significantly enhance the competitiveness, safety, and sustainability of MSME-scale food processing. The House of Quality (HOQ) analysis revealed that the most influential factors affecting consumer satisfaction are system effectiveness, process stability, and operational accuracy. These parameters are strongly correlated with consumer needs such as compact size, multifunctionality, ease of cleaning, and durability. By translating these needs into technical priorities, the study identified the wood and heat-resistant plastic hybrid design as the optimal configuration, balancing thermal endurance, ease of maintenance, and aesthetic appeal. The empirical validation showing consumer satisfaction scores between 4.2–4.5 reinforces that this concept successfully addresses both functional and psychological expectations. From a practical perspective, the study delivers a replicable model for MSMEs seeking affordable technology to improve product hygiene and durability. The developed spinner prototype offers a tangible solution for reducing residual oil content, improving food safety, and enhancing consumer trust—elements that directly impact MSME competitiveness and market acceptance. Moreover, the hybrid material approach introduces a sustainable framework for design choices that integrate ergonomic, environmental, and economic considerations.

The research underscores a broader scientific implication: the success of product innovation in MSMEs is not determined solely by technological sophistication but by the degree of responsiveness to end-user needs. Integrating QFD into MSME product development creates a feedback-rich ecosystem in which design decisions are guided by empirical data, user experience, and sustainability imperatives. This approach reinforces the transition toward a human-centered, data-driven, and sustainable MSME industrial model, setting a benchmark for future studies in ergonomic and hygienic product innovation.

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