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Design and Development of an Innovation Model for the Opak Machine at Opak Ketan MSMEs Cibuaya Karawang using the House of Quality Method

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A B S T R A C T

One of the MSMEs (Micro, Small Medium Enterprise) in the food sector located in Cibuaya Karawang area, namely Opak Ketan MSMEs, still carries out the opak production process manually, resulting in various shapes and diameters of opak. Opak ketan itself is made from a type of opak with different sizes and thicknesses, such as larger and thicker opak, and smaller opak with thin thickness and a crisp texture due to being baked. According to field analysis and interviews conducted at the research site, the manual production process presents difficulties and causes fatigue for workers, particularly in the formation of opak diameter and thickness. The printing process is done one by one (repeatedly), making it time-consuming and causing fatigue for workers who sit for long periods. As a result, the shape and thickness of opak lack precision (inconsistencies in size), leading to a lack of standardization. In terms of work activities, workers easily experience fatigue, particularly in their hands, waist, and back due to repetitive static movements. Ergonomically, working conditions are a factor that can enhance productivity, safety, and comfort for workers. Therefore, there is a need for the development and design of a suitable technology innovation model that can facilitate opak workers by creating a tool for printing opak ketan using an opak printing machine. This innovation can influence increased production capacity to be faster and standardized in shape and thickness. This design also applies the House of Quality (HOQ) model which successfully links consumer desires with a product design which produces 10 assumed criteria and 15 characteristics in order of importance. So it is concluded that the first priority that needs to be taken into account is determining price, flexibility and engine resources (fuel).

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1. INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are a crucial pillar of Indonesia's economic development that needs to be consistently supported and its performance enhanced. According to data from the Press Release of the Coordinating Ministry for Economic Affairs of the Republic of Indonesia

in 2023, MSMEs have contributed approximately IDR 9,580 trillion to the Gross Domestic Product (GDP) and have absorbed 97% of the total workforce (Limanseto, 2023). The number of MSMEs in Karawang District increases annually, particularly in the food and beverage sector (Purwandari, 2022) (Silviana et al., 2018). One of the MSMEs in the food sector located in Cibuaya, Karawang, namely Opak Ketan MSME, has been established for approximately 30 years since 1985. Opak ketan produced consists of various types with different sizes and thicknesses, such as larger and thicker ones, and smaller ones with thin thickness and a crispy texture due to being baked, as shown in Figure 1 below.

Figure 1. Opak ketan Cibuaya-Karawang

The Opak Ketan MSME is managed by the community residing in a specific area (alley/village) known as Gang Opak, as depicted in Figure 2. The community in this alley/village engages in the traditional production of opak ketan, which has been passed down through generations, preserved, and has also become legendary.

Figure 2. Location of opak Cibuaya

The high sales of Opak Ketan, which is considered a specialty food/souvenir of Karawang, have led to an increase in opak production. In its manufacturing process, opak is entirely made manually and simply, such as in kneading the ingredients, forming the diameter and thickness of opak, drying, and packaging. According to field analysis and interviews conducted at the research site, the process that poses difficulty and causes fatigue for workers is particularly in the formation of opak diameter and thickness, as illustrated in Figure 3.

Figure 3. Opak forming process

The printing process is done one by one (repeatedly), making it lengthy and causing fatigue for workers as it requires sitting for extended periods. This can result in inconsistent shapes and thicknesses of opak, leading to a lack of standardization. In terms of work activity, workers easily tire, experiencing fatigue in their hands, waist, and back due to repetitive static movements. Ergonomically, working conditions are a factor that can enhance productivity, safety, and comfort for the workers (Niati et al., 2022). Therefore, there is a need for the development and design of a suitable technology innovation model that can facilitate opak workers by creating a tool for printing opak ketan using an opak printing machine. This innovation can influence increased production capacity to be faster and standardized in shape and thickness (Ramadani et al., 2023). The design also applies the House of Quality (HOQ) model, where HOQ has successfully connected consumer desires with product design (Zulkarnain et al., 2023) (El Hadi, 2022).

Based on the background and problem formulation at the research site, the problem-solving approach undertaken includes: 1) Determining the shape of opak in terms of diameter and thickness to achieve standardized

sizes; 2) Determining the appropriate design and materials for making the opak printing machine to ensure it does not compromise food quality; and 3) Designing the opak printing machine with cost considerations.

This study examines several previous research studies to produce research innovations presented in the state of the art in Table 1.

Table 1. State of the art (SOTA)

State of The Art		(Sugandi et al., 2018)	(Siswadi & Nugroho, 2021)	(Ramadani et al., 2023)	(Debora, et al., 2024) [Current Research]
Machine Design	Printing equipment: - diameter 8 cm - hole 28 - thickness 1 mm			x	
	Printing equipment: - diameter 2.2 – 2.5 cm - hole 8 - thickness 3 mm	x			
	Printing equipment with development design		x		
	Printing equipment with customizable design development of diameter, hole, and thickness				x
MSMEs Product	Opak Singkong	x		x	
	Opak Jepit		x		
	Opak Ketan				x

2. LITERATURE REVIEW

A. MSMEs Opak Ketan

Opak Ketan is a traditional Indonesian snack made from glutinous rice, known for its unique taste and cultural significance. The production and sale of Opak Ketan are primarily driven by Micro, Small, and Medium Enterprises (MSMEs), which play a crucial role in sustaining this culinary tradition while contributing to local economies. MSMEs are essential in preserving and promoting traditional foods like Opak Ketan in Indonesia. They face several challenges, including access to raw materials, technological adoption, and effective marketing. However, with government support, capacity-building programs, and recent digital advancements, these enterprises have the potential to thrive and contribute significantly to local economies and cultural preservation. MSMEs involved in Opak Ketan production help preserve traditional culinary practices while contributing to the local economy. These enterprises often operate in rural areas, providing employment and income to local communities (Pratama et al., 2023).

Opak ketan business operators are part of one of the creative industries in the culinary field where opak ketan is a traditional snack from West Java and has the potential to expand beyond West Java. The creative industry in this culinary field generally already has a broad market and can compete with the modern retail market because it has higher economic value while still making a profit (El Hadi, 2022) (El Hadi, 2022). However, many MSMEs in this sector still rely on traditional production methods, which can limit scalability and efficiency. Limited access to modern equipment and technology hinders their ability to innovate and improve productivity (Purwandari, 2022).

B. Opak Machine Priority

Currently, sticky rice opaque businesses in Cibuaya still rely on the manual/traditional

opaque printing process which requires quite a lot of time and effort. This activity causes many obstacles such as: physical fatigue, discrepancies in opaque diameters, and also the lack of standardization of the daily opaque targets that entrepreneurs are able to set. Therefore, efforts were made to design the machine according to the wishes and expectations of the user in order to overcome the obstacles in making Opak in Cibuaya using the House of Quality method. The design of the opaque printing aids that will be designed is adjusted to two design parts, namely functional design and structural design. Functional design is the result of designing a system component that has functions that support each other to run the system. Meanwhile, structural design is carried out to determine the components and structure of the machine design that will be realized according to the criteria to produce an opaque printing tool that meets the desired specifications (Sugandi et al., 2018).

3. RESEARCH METHOD

The implementation of this research uses quantitative methods with research instruments in the form of data recording tables obtained from interviews with partners and literature techniques from books and previous researchers' journals related to the analysis of the design of printing machine aids for Opak MSMEs. Several research stages will be carried out during the research implementation until the predetermined research outputs are achieved. The following are the research methods that will be used:

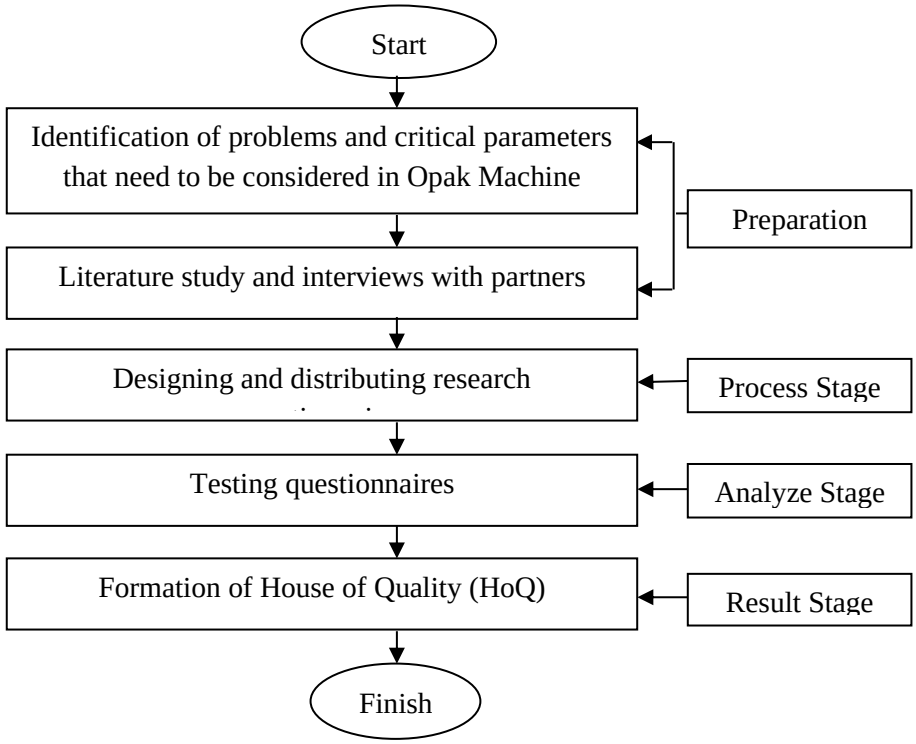

Figure 4. Flowchart of research method

A. Preparation Stage

Identification of problems and critical parameters that need to be considered in the design of the machine related to the shape (thickness and diameter) of the opak, which are still varied and uneven. Identification of the determination of machine manufacturing materials to ensure they do not alter the quality of the opak. Identification of consumer desires regarding the expected opak machine design.

Literature study is conducted to understand the existing printing machine designs as references, review the latest technology in machine manufacturing and opak material processing, and study relevant machine design principles.

Meanwhile, interviews are conducted to identify attributes and review partner needs to achieve precision in printing the diameter and shape of the opak.

B. Process Stage

- The research questionnaire design is derived from the attributes obtained from interviews, using a Likert scale on the questionnaire. The research questionnaire is distributed to 100 respondents, with sample selection based on purposive sampling method using the Slovin formula: $n = N/(1+Ne^2)$

  Explanation:
  n = number of research samples
  N = population size
  e = margin of error or tolerance for inaccuracy

C. Analyze Stage

• The results of the questionnaire were analyzed to obtain a clustering consisting of Age (Years Old) and Long time in business. This is the basis for the validity of filling out the questionnaire by parties who have been in the opaque business for a long time.

D. Result Stage

The formation of the House of Quality consists of several processes (Cohen, 1995): 1) Customer Needs and Benefits; 2) Planning Matrix; 3) Technical Response; 4) Relationship (influence of technical requirements on customer needs); 5) Technical Correlations; 6) Technical Matrix (importance level and target for technical requirements).

The conceptual design involves creating an initial concept for the printing machine and determining how the machine will handle variations in diameter and shape of the opak.

Testing is conducted using simulations of the machine prototype results to assess shape and function according to the HoQ results. Through HoQ results, the comparison between using the machine and manual methods in printing opak will be evaluated.

4. RESULT AND DISCUSSION

A. Questionnaire Result

A questionnaire was created and given to 30 Opak entrepreneurs in the Cibuaya area. The results of the questionnaire produced data on gender, age of the entrepreneur, and the length of time the entrepreneur has owned the Opak business as shown in Table 2.

Table 2. Questionnaire result

Gender	Man	15
	Women	15
Age (Years old)	20 - 30	9
	30 - 35	13
	> 35	8
Long time in business	1 - 2	5
	3 - 4	16
	> 5	9

Based on the results of the questionnaire, it is known that the average entrepreneur has had an Opak business for a period of 3 years. So the problems with Opak MSME need to be a priority for improvement with the existence of The Opak Printing Machine Innovation Model.

B. House of Quality

The use of manual printing processes (by hand) and machine design has a comparison of satisfaction from opaque entrepreneurs. This is illustrated in the HoQ which is arranged in the HoQ matrix and is carried out in stages (Rahma et al., 2024) (Gumintang & Akbar, 2023) (Prasetiyo et al., 2022) (Pangastuti, 2024) (Sibarani et al., 2024) (Nugroho & siswadi, 2020) :

A. Customer Need and Disires
   Determining customer needs and desires based on the results of questionnaires that have been distributed to respondents (voice of customer/VOC).
B. Planning Matrix
   Planning matrix is a place to determine product targets/objectives based on market research and calculations to sort consumer wants and needs.
C. Techincal Response
   Technical response is the answer to the question “how” customer needs can be met.
D. Relationships
   Relationship is an assessment of the strength of the relationship between customer needs and technical response

attributes with a rating scale of 0/empty (not related), 1 (weak), 3 (medium), and 5 (very related).

E. Technical Response Correlation
Technical correlation explains the correlation between technical responses between one another and is symbolized by the symbols + (very related), - (related), o (slightly related), and empty (not related).

F. Technical Requirements Matrix
The technical matrix is the order of importance of technical responses, information regarding technical competition comparisons, and technical targets.

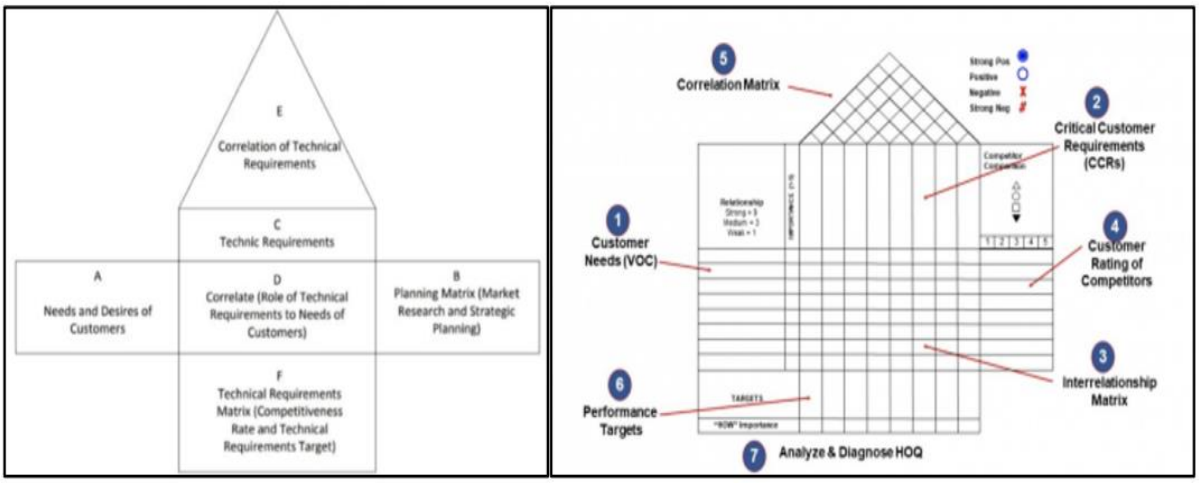

Figure 5. Matrix house of quality
Source: (Rahma et al., 2024; Handika et al., 2021)

The results of the comparison of the manual printing process (by hand) and machine design resulted in the preference of Opak entrepreneurs' needs in order of priority, namely:

1. Quantity Of Printing Results
2. Diameter of Opak
3. Affordable Machine Prices
4. Resources (Fuel)
5. Machine Power Source (Electricity)
6. Easy To Clean
7. Easy To Use
8. Does Not Affect Product Quality
9. Easy To Move
10. Machine Weight Measurement

Efforts are made to ensure that the results of the questionnaire given to Opak entrepreneurs are in accordance with the desires and satisfaction of its users so that they can fulfill their needs, hopes, desires and not cause complaints (Basuki et al., 2020). The recapitulation results show the absolute importance and relative importance values as shown in Table 3 below:

Table 3. Priority order of consumer needs (absolut dan relative importance)

No	Quality Characteristics	Absolut Importance	Relative Importance
1	Machine Price10 – 15 milion	344.5	8.8
2	Machine Price 20 – 25 milion	344.5	8.8
3	Diameter 3 cm – 5 cm	344.2	8.8
4	Fuel Resource	341.7	8.8
5	Electrical Resource	340.6	8.7
6	Qty of Printing > 1 Opak	305.9	7.9
7	Easy to Move	284.6	7.3

No	Quality Characteristics	Absolut Importance	Relative Importance
8	Easy to Use	271.8	7.0
9	Easy to Clean	207.9	7.0
10	Heavy	186.1	4.8
11	Diameter 3 cm	185.7	4.8
12	Diameter 5 cm	185.7	4.8
13	Not Affect Product Quality	165.2	4.2
14	Qty of Printing 1 Opak	163.7	4.2
15	Machne Price 20 – 25 milion	161.5	4.1

Based on the process of each stage, it can be concluded that determining price, diameter flexibility and engine resources (fuel) are the first priorities because they have high importance and relative weight values. The analysis results were then validated through interviews. The results of the analysis and interviews with entrepreneurs explained that the results of data processing and analysis were as expected. So the data processing results can be said to be valid because they comply with the criteria and the HoQ results are displayed as in Figure 6.

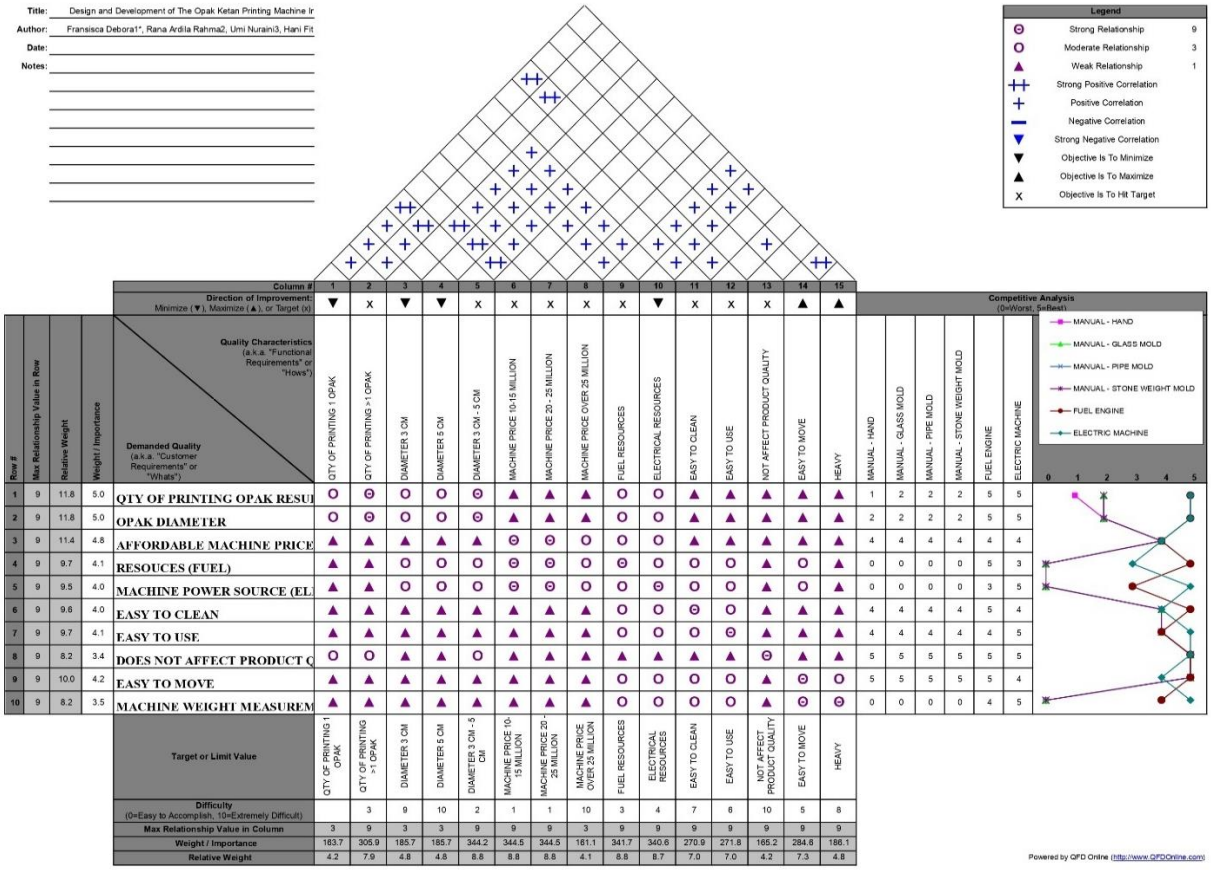

Figure 6. Matrix house of quality design machine opak

5. CONCLUSION

Based on the processing results, it can be concluded that using the House of Quality method a priority order has been produced that needs to be considered when selecting Opak printing equipment that can increase production productivity in accordance with customer needs (voice of the customer). The results obtained are recommendations that are needed in the consideration criteria for determining printing equipment with the assumption of 10 criteria including: 1) Quantity of Printing Results, 2) Opaque Diameter, 3) Affordable Machine Prices, 4) Resources (Fuel), 5) Machine Power Source (Electricity) , 6) Easy To Clean, 7) Easy To Use, 8) Not Affect Product Quality, 9) Easy

To Move and 10) Machine Weight Measurement. Meanwhile, the characteristics of the quality of printing equipment obtained from the questionnaire results consist of 15 characteristics based on the order of importance, including: 1) Machine Price 10 – 15 million, 2) Machine Price 20 – 25 million, 3) Diameter 3 cm – 5 cm, 4) Fuel Resource, 5) Electrical Resource, 6) Qty of Printing > 1 Opak, 7) Easy to Move, 8) Easy to Use, 9) Easy to Clean, 10) Heavy, 11) Diameter 3 cm, 12) Diameter 5 cm, 13) Not Affect Product Quality, 14) Qty of Printing 1 Opak, 15) Machine Price 20 – 25 million. Based on these characteristics, it appears that the first priority that needs to be taken into account is determining a price of 10 - 15 million with an importance value of 344.5 and a price of 20 - 25 million with an importance value of 344.5, flexibility in diameter 3 cm - 5 cm with an importance value of 344.2 and machine resources. (fuel) with an importance value of 341.7. Further research can be continued by creating 2D - 3D drawings of machine designs according to HoQ information and creating the resulting drawings into functional tools.

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