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Handel Design for Wok Frypan Type Pan

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ABSTRACT

Yogyakarta metal SMEs are required to continue to innovate and develop technology to be able to adapt to market demands. Metal SME'S is under the auspices of the Yogyakarta Metal Technical Implementation Unit (UPT). Metal UPT is responsible for carrying out research and studies on metal quality as well as studies on the development of metal product design technology. A large number of products from abroad makes metal SMEs must be able to compete in the market. Metal SMEs must be able to provide superiority to their products, one of the advantages that is built is presenting cookware designs, especially frypan works so that they have a competitive advantage. This study aims to determine the attributes and technical responses of the Wok Frypan-type handle product and to create a product prototype. Product technical attributes and responses were searched using the QFD method based on consumer desires. To overcome the problem of contradictions in QFD, the TRIZ method is used. The research resulted in a prototype design based on 11 attributes and 12 technical responses to the wok frypan-type Handel product.

Keywords: *Handle, QFD, TRIZ, Wok frypan.*

Introduction

According to the 2020 Regional Fiscal Study report, D.I. Yogyakarta the largest contributor to the formation of the 2020 DIY GRDP structure according to business fields is the processing industry, which amounted to Rp 17.76 trillion or 12.83% of the total DIY GDP. More than 90 percent of the processing industry in DIY is Micro Small Enterprises (MSEs), one of which is a metal SME's. Yogyakarta metal SME's is a metal processing industry in the form of household accessories, automotive spare parts and cooking utensils (coockware). Metal SME's are under the guidance of the Yogyakarta metal Technical Implementation Unit (UPT). UPT logam is responsible for carrying out research and assessment of metal quality as well as assessing the development of metal product design technology according to Yogyakarta Mayor Regulation Number 78 of 2011 concerning the details of the duties of UPT metal. The development and technological innovation of today's home appliances must go beyond the function and design of the product and represent the needs and emotions of consumers [1].

One of the products produced by metal SME's is pans. Potential challenges faced in cookware production are related to the application of product design specification parameters [2]. In general, a pot has two main parts, namely the pot and the handle (handle). Often the handle on the pan feels uncomfortable because of the size that is not ergonomic or the size of the pan is heavy like the Wok Frypan type pan.

Work tools that are not ergonomic will result in workplace hazards, poor worker health, injuries, disabilities and musculoskeletal disorders that reduce productivity and quality of work [3]. Therefore, it will be very dangerous if you do not give ergonomic consideration to the design of a product [4]. This research focuses on designing the design of wok frypan type handles, with an ergonomic approach. Because it is in this handel component that users interact most often [5]. Product design is a process of designing products that consider customer experience [6].

This study aims to determine the attributes and technical responses of wok frypan type pan handle products and make product prototypes. Product attributes and technical responses are sought using the Quality Fuctuion Deployment (QFD) method based on consumer wishes. QFD is a method that can improve the quality of products or services by understanding consumer needs and relating them to the technical features needed in each stage of making the resulting product or service [7]. To overcome the problem of contradictions in QFD, the method of Teoriya Resheniya Izobreatatelskikh Zadach (TRIZ) [8] is used. TRIZ is defined as a theory-based system that combines creative approaches, systematic analysis, and mathematical applications to help solve innovation problems effectively [9].

QFD in research [10] is used to develop product quality models based on customer satisfaction for the process industry. The QFD method is used to analyze customer needs and identify product characteristics that

are important to customers. Furthermore, QFD is used to prioritize product characteristics and develop action plans to meet customer needs. This research shows that QFD can be used as an effective tool in developing product quality models based on customer satisfaction.

QFD makes it possible to translate process requirements into design attributes, but some contradictions arise from QFD evaluation. Therefore, to improve the emerging attributes of QFD, a systematic analysis based on TRIZ Theory has been developed to propose innovative solutions. Studies on the integration between QFD and TRIZ can be found in the literature. In particular, M. Mayda and H.R. Borklu in 2014 implemented a combined method that uses TRIZ first to identify innovative concepts, then QFD to meet customer needs [11]. [12] conducting research using the QFD and TRIZ methods which resulted in the development of a new toy product that can support the development of motor aspects according to consumer needs in the form of toys in the form of train transportation equipment that has features of crochet games, puzzles, and design. In addition, [13] it has also integrated TRIZ and QFD to carry out innovative designs of CAD printers.

Research Methods

The object of research observed was a handle for wok frypan type pans produced at UPT Logam located in Yogyakarta. The data collection stage is divided into two, namely pre-survey and survey. While the data processing stage begins with a recapitulation of the results of the pre-survey of the initial consumer desires which are then translated into handle attributes which are then used into surveys of the level of importance of these attributes.

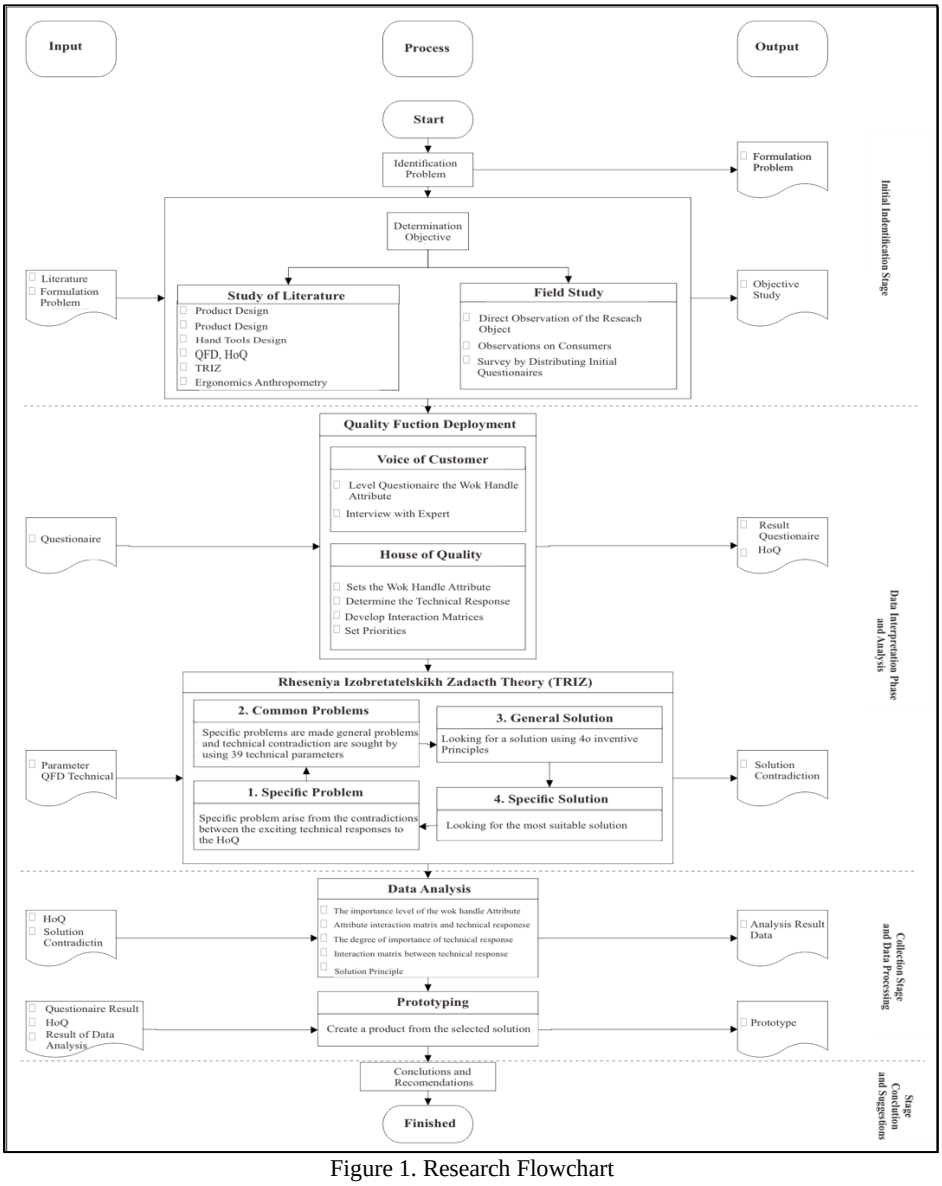

Figure 1. Research Flowchart

The data collection conducted first was a pre-survey obtained in two regions, namely Karanganyar and Yogyakarta, where this pre-survey was conducted by interviewing 30 initial respondents, namely housewives, chefs and UPT Logam Yogyakarta. This initial data collection is carried out to capture consumer wants or needs for pan handle products. Furthermore, the survey stage was carried out by providing questionnaires on the level of importance which were distributed to respondents, namely housewives, chefs, and metal UPT.

Furthermore, statistical tests were carried out, in the form of validity tests and reliability tests on questionnaires on the importance of handle attributes. Validity tests are used to ensure that a measuring instrument can measure the intended construct accurately [14]. Reliability testing refers to the extent to which a measuring instrument can provide consistent and reliable results in repeated measurements [15]. The results of valid and reliable questionnaire testing are then compiled on the house of quality (HoQ) matrix and the search for solutions from the contradictions that appear on the HoQ roof using the TRIZ method. House of Quality (HOQ) is a tool from QFD used to define design boundaries, show the relationship between respondent needs and matrix to meet respondent needs and illustrate the focus of the design team to produce quality products [16].

Results and Discussion

Matrix House of Quality

The data obtained and processed should be discussed and analyzed to achieve the research objectives. The prototype design process is also analyzed. Analysis of the entire HoQ matrix can be seen in Figure 2.

Row	Weight/Importance	Technical Respons / Customer Requirement	the base of the handles is designed upwards	handle is not designed with lots of holes where dirt	easy to disassemble	Hand grip anthroponetry measurements were taken	The length of the handle corresponds to the weight of the pan	The handle is designed with a hook hole	Joining the wok by means of a screw	Gives texture to the surface of the handle	Provides wrist support	Desain handle yang menarik dan unik	Attractive and unique handle design	Provide operation and maintenance records
1	4,21	Safe handle against fire from the stove	◉											
2	4,12	Handle is easy to clean		◉	○									○
3	4,55	Handle is comfortable to use				◉				◉				
4	3,94	The pan stays balanced when empty	▲				◉							
5	4,02	The pan is easy to store						◉						
6	3,88	The handle is firmly attached to the pan							◉					
7	3,78	Durable handle	◉						◉					○
8	4,53	Handle is not slippery				○				◉				
9	4,69	Minimize hand injuries									◉			
10	4,45	Unique and attractive handle shape	▲							▲	◉	◉	○	
11	3,07	Attractive handle color											◉	
		Unit	Degrees	Subjective	Subjective	Subjective	Subjective	Subjective	Subjective	Subjective	Subjective	Subjective	Subjective	Subjective
		Absolute Importance	80,3	37,08	13,65	49,05	35,46	36,18	68,94	86,17	82,26	40,05	35,08	23,7
		Relative Importance	14,23	6,57	2,42	8,69	6,28	6,41	12,22	15,27	14,58	8,69	6,22	4,2
		Rating	3	7	11	5	9	8	4	1	2	6	10	12

Figure 2. Overall HoQ Matrix

There are 12 attributes of skillet handles and each attribute has a level of importance. Attributes of skillet handle that have an average importance level of 5 or are very important attribute number 3 (easy to disassemble), number 8 (texture to the surface of the handle), and number 9 (provide wrist support). These three attributes correspond to the importance level value of 5 or are very important, therefore these three attributes must receive special attention in designing products because they are things that consumers really want. There is also an interaction or relationship between the attributes of the skillet handle and the technical response. There were fourteen strong interactions, 5 moderate interactions, and 3 weak interactions. The technical response column is a technical response obtained from translating the attributes of the skillet handle. There are twelve technicalities for the product design process. Each technical response has a degree of importance, which is displayed as an absolute importance value and a relative importance value. Technical responses are ranked from high to low. It can be seen that the highest absolute value is to give texture to the surface of the handle. The texture of this handle is very important because it involves several aspects, starting from the grip of the hand, the level of slippery, and the comfort of using the handle. The next important thing is to provide wrist support. Wrist support concerns the safety of the user of the panhandle, when using the pan handle for a long time or a heavy enough load then this is very influential.

Solution Principal Analysis

The upper part of the HoQ matrix has a strong negative correlation, which is solved by the TRIZ method. According to the completion of the TRIZ method, principle number 1 (segmentation) is established for a strong negative interaction between handles that do not have many holes where dirt and manages with hardpoint holes (hooks), this principle provides a solution for dividing objects into separate parts. This principle was chosen because the solution provided was in accordance with the problem at hand, namely separating the hardpoint hole from the main part of the handle. The hardpoint hole is explicitly designed to attach to the pan and at the same time can be used as an additional handle. Combining the handle with the pan can be done by designing the screw by minimizing the gap in the dirt, the screw can also be designed by cornering the screw head so that it is easier to clean and does not accumulate too much dirt. Combining by screwing also facilitates the process of disassembling the handle when the maintenance or cleaning process is conducted.

The relationship between the length of the handle according to the weight of the pan and providing wrist support is also produced by principle number 1, which provides a solution to divide the object into parts or grooves to reduce the length of the handle, so that the pan does not roll over easily. Handel is also in to be separated with a pan.

The two solutions are then arranged into the most appropriate solution to be applied to the design of pan handles. Based on the solutions obtained and the technical response to HoQ, a wok handle product design was made. These two solutions are then designed as the most suitable solution for handle design. Based on the solution received and the technical response from HoQ, a product design was made for the pan handle.

Prototype Design

Prototypes are used for evaluation for product development and further analysis. Product design is made based on the results of QFD data processing and solving contradiction problems using the TRIZ method which is compiled into one most appropriate solution.

Prototypes are used for product development and evaluation for further analysis. The product design is based on the results of QFD data processing and problem-solving contradictions with the TRIZ method for optimal solutions.

Handle Diameter Size

Based on the different types of hand grips, the correct grip for grip is a power grasp. Based on observations, the grip used is the grip between the thumb and index finger. The position of the thumb is not right at the tip of the index finger, but there is an overlap (overlap) of one knuckle. The diameter of the grip is determined by interpolating the overlap of half the knuckles. It is assumed that 1 knuckle is 3 cm, then for a half-finger overlap there will be an overlap of 1.5 cm. The circumference of the diameter will be reduced by 1.5 cm, which is 12.24 cm (5th percentile), 12.91 cm (50th percentile), and 13.57 (95th percentile), to find the overlap of the 5th percentile, 50th percentile, and 95th percentile as follows:

5^{th} percentile
Percentage of overlap of hand grip circumference = 1.5 cm / 13.74 cm X 100% = 10.92%

5th percentile overlap (in cm) = 10.92% X 3.80 cm = 0.42 cm
50th percentile
Percentage of overlap of hand grip circumference = 1.5 cm / 14.41 cm X 100% = 10.41%
50th percentile overlap (in cm) = 10.41% X 3.90 cm = 0.41 cm
95th percentile
Percentage of overlap of hand grip circumference = 1.5 cm / 15.07 cm X 100% = 9.96%
50th percentile overlap (in cm) = 9.96% X 4.00 cm = 0.40 cm

Find the values of the 5th percentile, 50th percentile, and 95th percentile after the half-finger overlap is as follows:

5th percentile
After deducting overlap: 3.80 cm – 0.42 cm = 3.38 cm
50th percentile
After subtracting overlap: 3.90 cm – 0.41 cm = 3.39 cm
95th percentile
After subtracting overlap: 4.00 cm – 0.40 cm = 3.60 cm

The percentile values after subtracting overlap were 3.38 cm (5th percentile), 3.39 cm (50th percentile), and 3.60 cm (95th percentile), respectively. The 5th percentile was selected as a small handle size and suitable for people with smaller hand sizes, while the 95th percentile was chosen as a large handle size and suitable for people with larger hand sizes. The 50th percentile was probably chosen as the middle measure suitable for most users [17]. So based on calculations, the diameter of the pan handle in accordance with the anthropometric data is 3.38 cm (smallest diameter), 3.39 cm (middle diameter) and 3.60 cm (largest diameter).

Additional Handle Size

Additional handles are created based on resolving contradictions using TRIZ. The size of the additional handle is based on the width of the palm (4 fingers) which is 8.80 cm for the 95th percentile so that people with wide hands will still be able to insert their hands into the additional handle.

Curved Corner Size

Curved corners are made based on trials to consumers directly. There are several samples of curvature that are assumed to be manages. From the results of the curvature test, it is found that the curvature that is comfortable to use by consumers is close to an angle of 45 degrees. Looking at the research conducted by [10], presented in Figure 3 the recommended curved angle is 45 degrees according to the comfort level of the wrist.

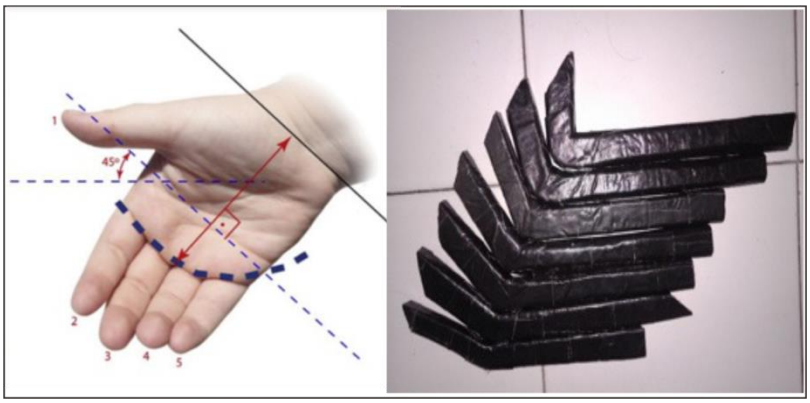

Figure 3. Handel Curvature Angle

Researchers conducted curvature tests using a simple protype as shown in Figure 3. The angle of curvature of the prototype varies, ranging from 30 to 90 degrees.

Main Handle Prototype

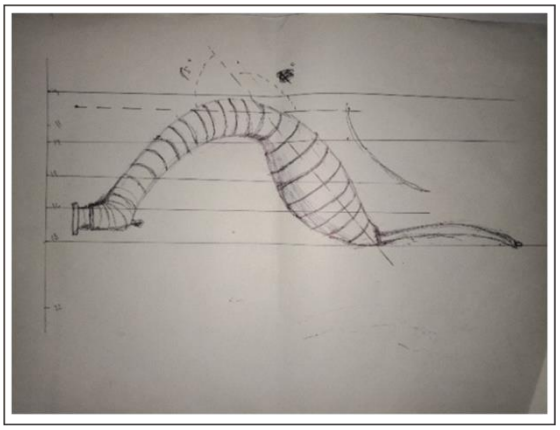

Figure 4. Initial Concept of Prototype

The initial concept of the prototype was designed based on the curvature angle of 45 degrees. The results of the initial design can be seen in Figure 4. The initial design was inspired by the body of a bee perched on a flower. So that it became the initial concept of the handle prototype.

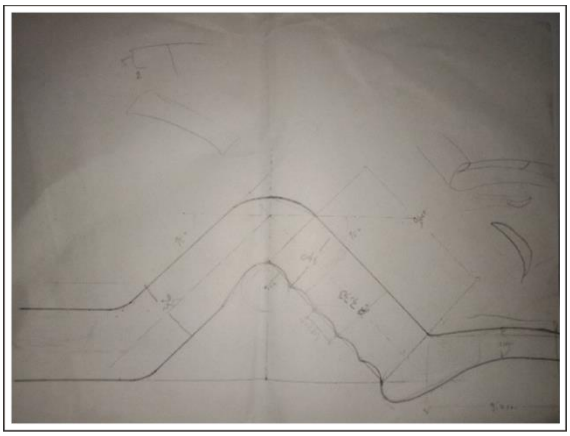

Figure 5. Prototype Concept Size

Figure 5 is an improvement from the initial concept of the prototype with considerations in terms of ergonomics. The handle design is measured and shaped according to the grip of the human hand.

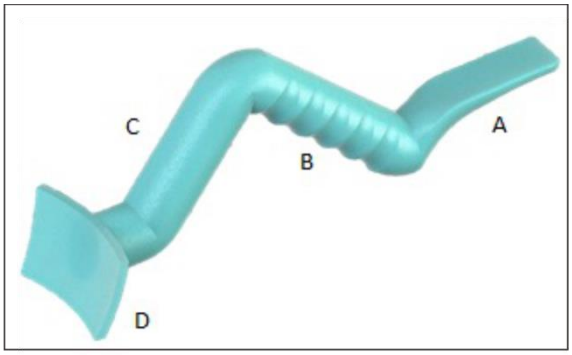

Figure 6. Prototype of the Main Handel of the Frying pan

Figure 6 above is the result of the design of a wok frypan type pan handle product. Part A is a handle support that delivers weight to the arm to help reduce the load on the wrist. Part B is the part for grasping the

hand that has been measured according to the diameter of the hand grip. Part C is the distributor of handles from the hand to the pan. And part D is the plate part where the handle joins the pan with the pan.

The handle above is an ergonomic handle, the size of the handle has been adjusted to the size of the human hand. The curved handle with a curvature of 45 degrees was obtained from direct observation to consumers and saw from research conducted by [18] which has examined laparoscopic tool handles. Handles with supports allow users to be more comfortable when using handles when cooking with heavy loads or for long periods and repeatedly. In part B the handle is textured so that the handle is not slippery when exposed to oil or other cooking ingredients. Part C is made up because to avoid the handle being hit by a fire strike from the stove, if the handle is made straight when the fire is too large it will be able to burn the handle. Part D is a part for joining handles with pans, combining using 4 screws so that the handles are strong and easy to disassemble during the cleaning process.

Additional Handle Prototype

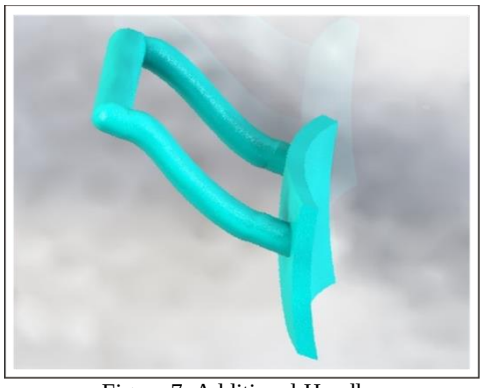

Figure 7. Additional Handles

Additional handles are made based on the principle of segmentation solution, which provides a solution to divide objects into other objects, namely separating the hardpoint holes into other parts or modules that can be separated from the main handle, which is to make new parts that are directly attached to the pan, this part can also be used as a helper handle when lifting heavy loads. The installation of additional handles is to attach the pan to the opposite part of the main handle.

Handle Material

The material of this handle uses thermosetting plastics. This material has rubber-like crosslinking molecules [19]. So that this material does not melt. Instead, this material decomposes at high temperatures. This material has good electrical properties, high temperature resistance and can also be made very rigid if using reinforcement. The downside is that the machining process can be long and difficult to recycle [20].

Wok Frypan's Intact Design

Figure 8. Wok Frypan Pan Whole Design

Figure 8 above is a combined design between a handle and a pan. This wok consists of a main wok and a wok handle.

Conclusion

Research shows there are eleven attributes of wok frypan handles. The attributes of pan handles are sorted by importance, namely minimizing hand injuries, comfortable to use, not slippery, unique, and attractive shape, safe against fire from the stove, easy to clean, easy to store, pan remains balanced when empty, firmly attached to the pan, durable, attractive handle color.

There are twelve technical responses to wok frypan handles. The technical response of the pan handle product is sorted based on its priority, namely providing texture to the surface of the handle, providing wrist support, the base of the handle up, combining with the pan by screwing, anthropometric measurements of the hand grip, interesting and unique handles, not in many holes where dirt can be, handles in with storage holes, the length of the handle according to the weight of the pan, There are several color options, easy to disassemble, provide a record of operation and maintenance The prototype of the wok frypan handle is as follows:

Figure 9. Final Prototype

The prototype of the wok frypan type pan handle obtained looks like the picture above. The handle is a handle based on the user's wishes. Further research on this product can be done by measuring the length of the hand rest to add comfort and reduce wrist strain when cooking in large quantities or over long periods of time.

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