PRODUCT REDESIGN BASED ON USER EXPERIENCE, COMPLAINT, AND FAILURE ANALYSIS

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ABSTRACT: User experience is a critical factor of product quality, especially for a manufacturer which launches product redesign similar to those of its competitors in the same market. Redesign in product development is necessary for the manufacturing industry to withstand competition. Every product would be customized to meet customer needs. Customer satisfaction is essential, and avoiding customer dissatisfaction is critical. Customers have the possibility of receiving a faulty item and subsequently lodging a complaint. Users' unfavorable experiences with a product could be used as feedback to improve its design. Product redesign begins with the identification of functional components. Customer needs are generally utilized to prioritize functional components, whereas complaints and failure modes, which are also crucial for improving product reliability, are often overlooked. This study utilized customer requirements, complaints, and failure analysis to determine the critical components of a two-burner stove. The method accomodates the failure mode and effect analysis (FMEA) and the Kano model to improve product failure and bolster customer satisfaction. Results of the implementation framework indicated that pan support is could

not attach tightly. The dented main body, a hard-to-assemble body plate, and a hard-to-assemble side plate are the top three priorities to be redesigned.

KEYWORDS: *Complaint; Failure Mode Effect Analysis; Kano; Product Redesign; User Experience*

1.0 INTRODUCTION

Most new products in the market today are developed using redesign techniques [1]. A product that has been on the market for a while must be redesigned to maintain its competitiveness. There are numerous motivations for redesigning a product. Design flaws may be identified, or the needs of customers may change [1]. In addition to enhancing quality, reducing costs, extending product life, and minimizing environmental impacts, product redesign can also enhance product quality, cut expenses, and lengthen product durability. Consequently, product redesign is a fundamental aspect of product development.

User satisfaction and complaints are reflected in the user experience. This information contributes to the enhancement of product quality. The process of developing a produced product encompasses customer specifications, starting from the first concept stage and extending to the detailed technical design., but also the initial concept, engineering design [2], [3], [4] and also customer complaints [5], [6], [7], [8]. In prior research, an integration model for product development based on FMEA-Kano has been developed. These studies strive to enhance quality and customer satisfaction by better understanding customer needs and design requirements [9], [10], [11]. Shahin et al.[12], [13] and Ma et al. [11], [14] determined which product components could be designed more reliably through an integration model of QFD-FMEA. Ginting et al. [15] effectively describe the combination of DFMA and QFD model in a brief literature review.

There are research opportunities in QFD-FMEA and DFMA approaches, dealing with the industry's engagement to increase competitiveness and product quality. The QFD-FMEA model is used to analyze consumer needs and product failure mechanisms. In addition to meeting consumer needs in design improvement, uncertainty and risk of failure should also be considered in the decision-making process at the initial design stage. These considerations help determine the manufacturing process planning strategy [16], [17].

Moreover, it is challenging to figure out accurately difficulties in product redesign at the early design phase, particularly when it comes to ensuring customer satisfaction by addressing customer complaints and accomodating failure modes data from user experience. Various integrated design models were developed and offered to deal with this problem. Nonetheless, initiatives to incorporate all three factors into the early conceptual planning phase of product redesign have yet to be successful. The research question addressed in this study is how user experience can be used to determine the critical components. To answer this question, this research develops and implements an integrated framework of product redesign based on user experience, which includes customer needs, complaints, and failure modes. The objective is to determine the priority of product redesign components.

2.0 MATERIAL & METHODOLOGY

2.1 Basic Model

Any potential dissatisfaction consumers may experience during purchasing, using, or repairing the product is defined as complaint behaviors. The concept of complaint behaviours is a subfield within the realm of post-purchase consumer behaviour. Consumer complaints can indicate customer loyalty and dissatisfaction. Donoghue et al. [18] demonstrated that complaint behavior can encourage customer loss, while cost reduction by retaining loyal customers is prioritized over attracting new customers.

The Kano model determines whether there is a correlation between customer satisfaction and dissatisfaction and the extent to which consumer needs are met. In addition to fundamental and special requirements, Kano principles can help uncover extraneous variables that can be addressed without impacting the consumer's impression of the product or service.. The Kano model was chosen because it details the basic and specific criteria [4]. Shahin et al. [11], [17] incorporated the FMEA-Kano approach for product improvement to satisfy customer and design requirements more closely. Ma et al. [10]

established a model development for product redesign with higher reliability based on the QFD-FMEA approach. User experience and complaints are represented by consumer feedback. It is always the company's responsibility to improve a product in response to customer complaints or claims. It corresponds to the quality initiatives' practices.

FMEA is a method for identifying product component failure forms and analyzing product reliability. The process of identification, analysis, and the impact of failure on the product or system structure is carried out systematically by FMEA [17]. QFD is a product development approach utilizing consumer information to develop new product innovation strategies to satisfy customers optimally. Its main goal is to collect all the information on consumer demand for a product. The combination of the QFD and FMEA approaches also benefits Gu et al. [20] by considering the risk of each form of product failure and customer needs during the design process. FMEA analysis still needs to utilise pertinent data on customer needs and technical attributes to resolve the priority sequence for identifying failure modes. Therefore, integrating the QFD and FMEA diagnostic approaches could cooperate with failure reduction. As shown in Fig. 1, this study investigates the conformance and interdependence of FMEA and QFD and develops an integration framework for FMEA and QFD based on customer complaints.

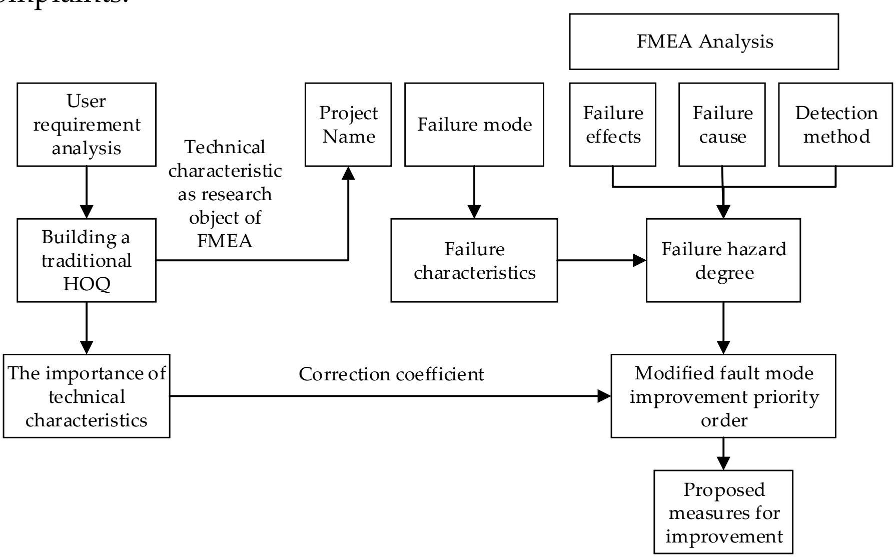


Figure 1: A basic model of integrated FMEA and QFD [20]

The QFD-FMEA methodology, employed in several contemporary investigations, is a technique for scrutinizing customer requirements and product malfunction mechanisms. Consumer needs play a crucial role in product design and enhancement. Uncertainty factors and failure risks in product redesign necessitate consideration of failure modes and risks throughout the decision-making process in the early design stage prior to applying strategies in the manufacturing process. However, it can be challenging to address issues in product redesign precisely during the early stages of early design, mainly when providing a user experience that accommodates consumer complaints and prior product failure modes. Some integrated design models have been put forth to deal with the issue.

Nonetheless, attempts to incorporate the three factors into the initial conceptual planning stage of product development have failed. An emerging challenge is using consumer feedback regarding product complaints alongside data on product failures to determine which components should be prioritised for redesign. This study presents a recommended methodology for redesigning a product based on an analysis of client needs, complaints, and failures.

2.2 Proposed Integrated Model Development

The integrated model's workflow is illustrated in Figure 2 . In the QFD analysis procedure, both FMEA and Kano-QFD are utilized for preliminary prediction analysis to ensure that the most dependable products with the lowest risk are produced to meet the end users' needs. They have strong complementarity and improve product reliability in multiple ways. The integrated solution in this study employs a new methodology to product pre-analysis. The kano-QFD model was developed in three phases, with the primary quality house deployment starting from user complaints and requirements to design characteristics. Since consumers provide real complaints, using complaints as a customer need in product development improves the accuracy of customers' requirements. The second is FMEA, which identifies potential failure modes, causes, and consequences. The FMEA yields the failure level as the risk priority number (RPN). The third deployment is the secondary quality house in response to the modified fault mode improvement priority proposal.

The proposed method integrates FMEA, Kano, and quality function deployment (QFD), utilizing Figure 1 as the basic model. Two phases of QFD are included in the proposed method. FMEA was updated with QFD's findings. Failure modes are prioritized in the first phase based on failure effects, and failure causes are prioritized in the second phase based on failure modes. In the second phase, the Kano questionnaire's quality was measured. The Kano two-dimensional quality classification was subsequently incorporated into the FMEA. In FMEA, the failure mode can affect and adjust the risk priority number (RPN). The proposed method is an example of the so-called "integration of FMEA and QFD" since QFD comprises the three main parts of FMEA.

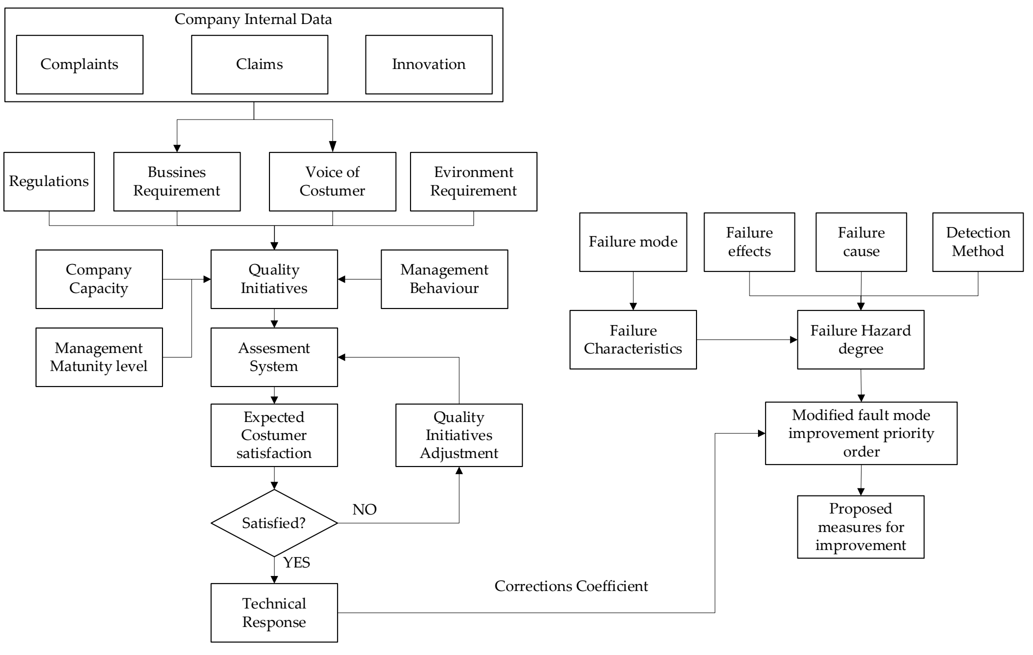


Figure 2. Proposed Integrated Model Development

2.3 User Experience Assessment based on FMEA-Kano Model Development

Through the phases of design planning and component assembly, the production-driven study procedure was analyzed. Failure of the component was identified using the company's FMEA assessment. From the assessment of 17 obtained components, 27 failure modes were used as parameters for product enhancement. The component function and failures listed in Table 3 served as a standard for later product quality measurements.

After identifying the failure modes, two additional stages were performed concurrently. First, the identified failure was evaluated by expert judgments to determine the priority failure from the company's perspective, and then it was processed with the customers' perspective in mind. The team of experts comprises design engineers, production engineers, R&D staff, quality engineers, and people who use the product. The Table 3 contains a comprehensive expert assessment of FMEA. In the second step, the study developed a Kano questionnaire to assess customer satisfaction. The questions consist of two primary components. For each failure, a pair of Kano questions were devised, to which the customers may respond with one of five possible feelings. Consequently, the Kano positive (functional) and negative (dysfunctional) questionnaire construct, including the 5-point response scale for each failure question, must be adjusted. However, 38 potential consumers were surveyed about their feelings regarding 27 serious product component failures. By understanding customer insights, prioritizing product enhancement could be made more relevant and on-target. The FMEA-Kano assessment's priority was determined in Table 3. Based on the assessment, the failure priority could be determined from both the company's and customers' perspectives. Table 1 provides the identified top ten potential failures that could be considered for improvement.

Based on Table 1, the study could obtain the potential failure by making specific improvements to the components related to the failure modes. At least 13 potential failure modes of nine components require improvement, whether from the company's or consumers' perspectives. However, the results do not show the priority of all the potential failure modes. Therefore, the data were assessed in the second step of the QFD assessment. Elements of the developed QFD is in agreement with Gu et al [20]. The list of components based on a potential failure mode is presented in Table 2.

Table 1. List of top ten priorities of potential failures

Priority	Company's perspectives	Customers' perspectives
1	F22	F24
2	F1	F22
3	F24	F1
4	F15	F25
5	F2	F27
6	F4	F12
7	F25	F15
8	F14	F2
9	F16	F4
10	F20	F13

Table 2. The potential failure mode of each component in detail

Failure Keyword	Component Name	Potential Failure Mode
F1	Main Body Plate	dented main plate body
F2		hard to assemble
F4	Side Plate	hard to assemble
F12	Pads	Loose pads
F13		wear-out
F14	Burner-cup	crusty
F15		expand
F16	Burner Cap	crusty
F20	Burner Stem	crusty
F22	Lighter	ignition fails
F24	Knob	unable attached tightly
F25		stuck when it was rotated
F27	Pan Support	unable attached tightly

Table 3. List of stove component functions and failure mode

Failure Keyword	Component / Part Name	Function	Failure Mode
F1	Main plate body	to encase the internal components and serve as a base for other components placed above.	Dented main plate body
F2			hard to assemble
F3	Side plate	To provide lateral support for the Main Body Plate and serve as a seating component for the internal components.	dented side plate
F4			hard to assemble
F5	Bottom plate	to support the structure from behind	dented bottom plate
F6	Support pillar base	to reinforce and interconnect each plate more effectively	loose
F7			long assembly time
F8	Transversal Stiffener plate	to increase the strength of the structure and place the inside components	crack & bend
F9	Longitudinal stiffener plate	to enhance the structural integrity and properly position the internal parts of the ignition system.	crack & bend
F10	Inner pipeline	to assign the gas to the burner stem	crust
F11	Support base	to support the base of the structure	loose
F12	Pads	to stabilize the stove so it less	loose

Failure Keyword	Component / Part Name	Function	Failure Mode
F13		moving or shifting	wear-out
F14	Burner cup	to disperse the gas evenly before burning	crusty
F15			expand
F16	Burner cap	to ignite the flame	crusty
F17			expand
F18			failed to go get the fire out
F19	Screw	to join the components together	screw looseness
F20	Burner stem	to carry and enrich the gas before it is released into the burner	crusty
F21			expand
F22	Lighter	to ignite the flame	ignition fails
F23	Pipe hook	to hold up the pipe and not move easily	unable attached tightly
F24	Knob	activating and deactivating the stove, as well as adjusting the intensity of the flame.	unable attached tightly
F25			stuck from rotated
F26	Pan Support	to provide support and enhance the stability of the cookware throughout the cooking process	broken/crack
F27			unable attached tightly

3.0 RESULTS AND DISCUSSION

Arto Metal International Company is a local two-burner stove manufacturer in Sidoarjo, Indonesia. It was examined to determine the implementation of the proposed method. The gas stove manufacturing company was examined for product redesign and quality improvement. Consequently, this study aimed to enhance the quality and quantity of local industrial production throughout the past few years.

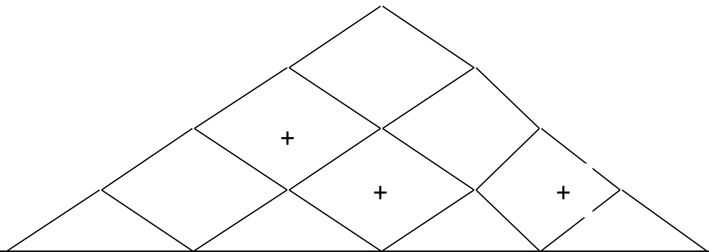
This study necessitates dependable and accurate data. Consequently, the questionnaire will undergo testing to ensure its reliability and validity before being employed as the primary data source. The most critical step in making the product design matrix is translating customer needs into technical needs. This research aims to explain the general specifications for the design that will be developed. The QFD assessment has two phases; the failure mode is prioritized based on failure effects and causes. House of Quality (HoQ) analysis was conducted using the approach. The analysis employed importance ratings derived from the severity weight of FMEA-Kano and the interrelationship weight in the cell provided on a three-point scale of engagement (strong: 9 symbolled ●; medium: 3 symbolled ○; and weak:1 symbolled ▽). The production manager filled out the technical characteristics questionnaire. The case study, which aimed to demonstrate the use of a pilot survey, had 34 respondents participating, selected through judgment sampling. The Pearson approach was used to validate the results and expectations of sorting tools. The reliability test of Kano model data was conducted using Alpha Cronbach, with a significance level of 5%. However, it's important to note that the use of such a small sample size may lead to unreliable results in some instances, which is a potential limitation of this study. The House of Quality (HOQ) matrix is derived from a questionnaire that assesses technical qualities and captures the requirements of quality control staff. The assessment of customer relevance based on technological attributes relies on the modus score of each question item in a closed questionnaire.

By considering the interrelationships between failure modes, failure effects, and failure causes, the suggested method is predicted to overcome a fundamental flaw of basic FMEA. After obtaining a list of potential failure modes from the FMEA-Kano phase, the next step is to rank thirteen potential failure modes based on the HoQ analysis of QFD. Figure 3 describes the HoQ analysis of the first QFD phase.

Once the first phase's data analysis is complete, the output weight should be transmitted to the second phase's assessment. In the second phase, importance ratings are determined using the inverse values of the priorities. The evaluation in the second phase will yield a more relevant weighting and failure mode ranking, which may be considered in design improvement in the recommendation steps. Figure 4 shows the QFD evaluation for the second phase.

Importance rating (severity)	Failure Modes / Failure Effects	Dented main body plate	Hard to assemble the main body plate	Hard to assemble side plate	Loose rubber pad	Wear-out rubber pad	Crusty burner cup	Expanded burner cup	Crusty burner cup	Crusty burner stem	Ignition lighter fail	The knob is unable attached tightly.	Knob stuck from rotated.	Pan support is unable attached tightly.
8	The structure changes	●	●	●				○				○	○	●
4	Moving structure	●	●	●	●	○								●
8	Ignition fails						○	△	○	○	●	△	●	
8	Imperfect flame/ red fire						●	○	●	●	●	△	○	
6	unstable	●	●	●	●	○								
	Total Weight	162	162	162	90	30	96	56	96	96	144	40	120	162

Figure 3. The first phase of QFD analysis



Importance Rating	Failure Causes / Failure Modes	Imprecise installation	Improper maintenance	Excessive	Overload	Total weight	Priority
1	Dented main body plate	●	○	○	●	24	2
1	Hard to assemble body plate	●	○	∇	∇	14	3
1	Hard to assemble side plate	●	○	∇	∇	14	3
0,2	Loose rubber pad	●	○	●	∇	4,4	7
0,13	Wear-out rubber pad	∇	●	●	∇	2,5	9
0,25	Crusty burner cup		●	●		4,5	6
0,17	Expanded burner cup		●	●		3	8
0,25	Crusty burner cap		●	●		4,5	6
0,25	Crusty burner stem		●	●		4,5	6
0,5	Ignition lighter fail		○	●		6	5
0,14	The knob is unable attached tightly.	●	○	○		2,14	10
0,33	Knob stuck from rotated.	●	●	●		9	4
1	Pan support is unable attached tightly.	●	●	●	●	36	1

Figure 4. The second phase of the QFD analysis

As Figure 4 shows, the priority of the potential failure mode can be determined. One of the benefits of integrating FMEA and QFD is the effect of new priorities of failure on their basic ranking on severity weight in a previous FMEA-Kano assessment. The emphasis outcomes from the failure mode are derived from the assessment. Hence, the second phase of QFD indicates that pan support is unable to attach tightly, the main body is dented, it is hard to assemble the body plate, and it is hard to assemble the side plate; these are the top three priorities to be redesigned.

Traditional FMEA in practical settings commonly uses the rudimentary Risk Priority Number (RPN), which has faced significant scrutiny in academic literature due to many shortcomings. Consequently, this approach imposes certain limitations on the effectiveness of problem-solving. One of FMEA's most critical unsolved problems is the need for more research on how failure modes, effects, and causes are related. A failure mode may have multiple potential causes with varying occurrence probabilities. It may appear challenging for FMEA practitioners to determine the severity of failures during the design phase and before their occurrence; however, the proposed method could provide this advantage through a new pair-wise Kano. In addition to this advantage, there may be some disadvantages associated with the new approach. The time-consuming nature of the survey, the inadequacy of the failure data, and the difficulty in locating customers who share the same feelings and reactions to product failures are three of the most significant limitations. Nevertheless, the proposed approach is more customer-centric than the conventional approach.

4.0 CONCLUSION

The objective of this research has been achieved. The proposed model development for product redesign was constructed by utilizing user experience, complaints, and failure analysis to determine the critical components of the product. The effectiveness of conventional FMEA has been enhanced, and to consider the interrelationships between FMEA elements, QFD was integrated with FMEA for this model development. The integration model develops in three phases. First, the deployment of key quality houses from user complaints and demands to design characteristics, is known as the Kano-QFD study. Customer requirements are enhanced in accuracy when complaints are utilized as a user experience for product improvement, as customers express factual grievances. Another method is FMEA, which involves identifying potential failure modes, their causes, and their implications. FMEA calculates the failure hazard rate and expresses it as a risk priority number (RPN). The third step involves implementing the secondary quality house based on the technical answer to the proposed priority for improving fault mode. The ARMET stove manufacturing company was used to examine the proposed two-phase QFD–FMEA approach. This study considers FMEA as an effective failure identification method for a product and the structure of its constituent components. Consequently, when employing FMEA, studies should examine the scope of the coverage by the quality of must-be products through the Kano approach and be based on customer perceptions of the severity of product failure's effect. Results of the implementation framework indicated that pan support could not attach tightly. The dented main body, a hard-to-assemble body plate, and a hard-to-assemble side plate are the top three priorities to be redesigned.

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AUTHOR CONTRIBUTIONS

A.I. Junaini, M.L. Singgih and P.D. Karningsih: Conceptualization, Methodology, Writing- Original Draft Preparation; A.I. Junaini, P.D. Karningsih, P.S and A. Artono: Data Curation, Validation, Supervision; A.I. Junaini, M.L. Singgih, and P.D. Karningsih, and P. Suwignjo: Software, Validation, Writing-Reviewing and Editing.

CONFLICTS OF INTEREST

The manuscript has not been published elsewhere and is not under consideration by other journals. All authors have approved the review, agree with its submission, and declare no conflict of interest on the manuscript.

REFERENCES

[1] S. Filippi and B. Motyl, "Interactive redesign of products' User eXperience: how to," *International Journal on Interactive Design and Manufacturing (IJIDeM)*, vol. 16, no. 1, pp. 65–80, 2022.

[2] Cakravastia, Andi Ameera Sayaka, and Anas Ma'ruf. "Indonesia e-Bike Consumer Preference Through Market Potential Research: A Choice-Based Conjoint Analysis." 4th International Conference on Informatics, Technology and Engineering 2023 (InCITE 2023). Atlantis Press, Yogyakarta, Indonesia, 2023, pp. 377-389.

[3] E. Nault, G. Peronato, E. Rey, and M. Andersen, "Review and critical analysis of early-design phase evaluation metrics for the solar potential of neighborhood designs," *Building Environment*, vol. 92, no.1, pp. 679–691, 2015.

[4] F. Shaker, A. Shahin, and S. Jahanyan, "Developing a two-phase QFD for improving FMEA: an integrative approach," *International Journal of Quality and Reliability Management*, vol. 36, no. 8, pp. 1454–1474, 2019.

[5] I. Emovon, "Failure Mode and Effects Analysis of Ship Systems Using an Integrated Dempster Shafer Theory and Electre Method," *Journal of Advanced Manufacturing Technology*, vol. 10, no. 1, 45-60, 2016.

[6] N. O. Erdil and O. M. Arani, "Quality function deployment: more than a design tool," *International Journal of Quality and Service Sciences*, vol. 11, no. 2, pp. 142–166, 2019.

[7] M. Relich, J. Adamczyk, R. Dylewski, A. Kister, "Case-Based Reasoning in Achieving Sustainability Targets of New Products," *Sustainability*, vol. 16, no. 4, p. 1502, 2024.

[8] A. I. Juniani, M. L. Singgih, and P. D. Karningsih, "Design for Manufacturing, Assembly, and Reliability: An Integrated Framework for Product Redesign and Innovation," *Designs*, vol. 6, no. 5, p.88, 2022.

[9] R. Tuertmann, M. Ruessmann, M. Schroeder, A. Linder, and R. Schmitt, "Challenges and design of a data-oriented complaint and failure management," *Total Quality Management Business Excellence*, vol. 27, no. 7–8, pp. 885–896, 2016.

[10] M. Suef, S. Suparno, and M. L. Singgih, "Categorizing product attributes efficiently in QFD-Kano: A case analysis in telecommunication," *Total Quality Management Journal*, vol. 29, no. 3, pp. 512–526, 2017.

[11] H. Ma, X. Chu, D. Xue, and D. Chen, "Identification of to-be-improved components for redesign of complex products and systems based on fuzzy QFD and FMEA," *Journal Intelligent Manufacture*, vol. 30, no. 2, pp. 623–639, 2016.

[12] A. Shahin, M. Pourhamidi, J. Antony, and S. H. Park, "Typology of Kano models: A critical review of literature and proposition of a revised model," *International Journal Quality Reliability Management*, vol. 30, no.

3, pp. 341–358, 2013.

[13] A. Shahin, S. Mohammadi, H. Harsij, and M. R. R. Qazi, "Revising satisfaction and dissatisfaction indexes of the Kano model by reclassifying indifference requirements: A case study of the presidential elections," *Total Quality Management Journal*, vol. 29, no. 1, pp. 37–54, 2017.

[14] H. Ma, X. Chu, and Y. Li, "An integrated approach to identify function components for product redesign based on analysis of customer requirements and failure risk," *Journal Intelligent Fuzzy System*, vol. 36, no. 2, pp. 1743–1757, 2016.

[15] R. Ginting, A. Ishak, and A. F. Malik, "Product development and design with a combination of design for manufacturing or assembly and quality function deployment: A literature review," *AIP Conferences Proceeding,* vol. 2217, Surakarta, Indonesia, 2020.

[16] C. F. Liew, J. Prakash, and K. S. Ong, "An FMEA-based integrated framework to quantify and improve operational performance in advanced manufacturing environments: A case study," *International Journal Production Quality Management*, vol. 28, no. 3, pp. 318–339, 2019.

[17] Prabowo, R.S., Setiawan, P.A., Juniani, A.I., Wiediartini, Erawati, I, "Reliability analysis of hanger shot blast KAZO machine in foundry plant," *MATEC Web of Conferences*, 204, art. no. 03007, Malang, Indonesia, 2018.

[18] E. Oney and I. Aghaei, "Consumer complaint intentions: the impact of general and specific self-confidence," *Journal of Marketing Analytics*, vol. 12, pp. 390–410, 2022.

[19] A. Shahin and S. Ebrahimi, "Revising the Interrelationship Matrix of House of Quality by the Kano Model," *TQM Journal*, vol. 33, no. 4, pp. 804-822, 2020.

[20] Y. K. Gu, Z. xin Cheng, and G. qi Qiu, "An improved FMEA analysis method based on QFD and TOPSIS theory," *International Journal on Interactive Design and Manufacturing*, vol. 13, no. 2, pp. 617–626, 2019.