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Optimization of Production Processes in Micro, Small, and Medium Metal Enterprises (SMEs Metal) using Fuzzy-Kano, QFD, and SPC Methods: a Systematic Literature Review

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***Abstract*—Micro, Small, and Medium Enterprises (MSMEs), particularly in the metal industry, play a pivotal role in Indonesia's economic development but face significant challenges in maintaining product quality, reducing defects, and responding to customer needs. This study conducts a Systematic Literature Review (SLR) to investigate the integration of Fuzzy-Kano, Quality Function Deployment (QFD), and Statistical Process Control (SPC) methods as a comprehensive approach for optimizing production processes in metal MSMEs. The literature was sourced from databases such as Scopus, Crossref, and Google Scholar, yielding 562 records, of which 35 relevant journal articles were analyzed in depth. Findings reveal that while QFD and SPC are frequently applied separately in MSMEs, research integrating these methods with Fuzzy-Kano remains limited. The review highlights that such integration offers substantial potential to improve product quality, align production with customer satisfaction, and enhance decision-making under uncertainty—ultimately supporting sustainable competitiveness. This study also identifies research gaps and proposes future directions, including the development of localized models tailored to SME contexts and the deeper integration of SPC within customer-oriented product development frameworks.**

***Keywords*: Deployment (QFD), Fuzzy-Kano, Metal SMEs, Production Optimization, Systematic Literature Review**

I. INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are vital and strategic in the Indonesian economy. According to [1], MSMEs contribute approximately 60.5% to the national Gross Domestic Product (GDP). This significant contribution highlights the vast potential of MSMEs in Indonesia to be further developed, enhancing their impact on the country's overall economic growth.

However, Micro, Small, and Medium Enterprises (MSMEs) in Indonesia face several significant challenges that hinder their growth and competitiveness. These challenges include financial constraints, limited knowledge and skills, human resource shortages, marketing and distribution difficulties, heavy dependence on owners, technological limitations, vulnerability to economic fluctuations, as well as organisational and management issues.

In East Java Province, there are numerous MSMEs, including those located in Waru District, Sidoarjo Regency, which consist of groups of MSMEs engaged in the metal sector. According to [2], quoting the Head of the Makmur Abadi Village-Owned Enterprise (Bumdes) in Ngingas Village, Zaenudin Arifin, there are a total of 340 small and medium industries (SMEs) actively producing in the area. However, only 215 IKMs have been recorded in detail. A common issue faced by IKMs in this region is their weak bargaining power, as products are often rejected by the market due to minor defects. Despite these defects being relatively small, they prevent the products from entering industrial orders, causing frequent losses for the SMEs. This situation arises because IKMs lack statistical quality control methods to reduce process variability, identify defect causes, and enhance product consistency. Additionally, there is no effective approach in place to systematically identify customer needs.

Therefore, an effective approach is needed to address these challenges. The integration of Fuzzy-Kano-QFD (Quality Function Deployment) and Statistical Process Control (SPC) offers a promising method for optimizing

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the production process. Fuzzy-Kano-QFD enables a more systematic identification of customer needs by incorporating subjective aspects through fuzzy logic. This approach helps classify customer preferences based on their expected level of satisfaction and translates these needs into technical product attributes. [3], In her research, she explained that QFD is a product planning and development method that allows a company to clearly define consumer desires and requirements, enabling the evaluation of the strengths and weaknesses of each product or service offered.

Conventional QFD has a limitation in that the determination of the relationship scale between technical characteristics and customer needs tends to be highly subjective. To address this, the present study develops a mathematical model that integrates Quality Function Deployment (QFD) with the Kano Model to establish more objective product quality improvement targets. [4] proposes an integrative framework combining SERVQUAL, Analytical Kano (A-Kano), and QFD using a fuzzy approach to support decision-making for service improvements in the education sector, demonstrating that the integration of these methods is feasible. Although the focus is on education, the methodology can be adapted to optimize production processes in metal MSMEs. Furthermore, Jin [5] integrates the Fuzzy Kano method, Analytic Hierarchy Process (AHP), Decision Making Trial and Evaluation Laboratory (DEMATEL), and QFD to design product development processes. Such integrations illustrate viable approaches for combining multiple methods to enhance decision-making and process optimization.

The integration of various methods into QFD serves to translate customer requirements into product characteristics and to prioritize design alternatives by considering both interdependencies and ambiguities. First, customer requirements are identified. Second, the Fuzzy Kano model is applied to evaluate the impact of each requirement, which is often ambiguous, on customer satisfaction. Third, design alternatives are proposed, and the relative importance of each requirement is determined using the Analytic Hierarchy Process (AHP). Finally, QFD is employed to select the optimal product design. The integration of fuzzy logic into QFD provides a powerful tool for enhancing product design and quality, enabling the development of a customer-focused quality system. This approach was successfully implemented in a company in Turkey that manufactures PVC window and door systems. [6].

Meanwhile, the application of Statistical Process Control (SPC) enables statistical-based quality control to reduce process variability, identify defect-causing factors, and enhance product consistency. By implementing this method, metal MSMEs can improve product quality, reduce defect rates, and increase operational efficiency, ultimately boosting their competitiveness in the market. As explained by Fakih [7], SPC can be used to identify product defects, quantify the percentage of those defects, determine their root causes, and, using the 5W + 1H method, propose appropriate corrective actions. Similarly, Ignatio [8] emphasizes that SPC allows for early detection and prevention of production issues and has distinct advantages over traditional quality methods, such as final product inspection. Furthermore, Michaela [9] discusses the integration of QFD and SPC in product design and manufacturing processes. This integration demonstrates how combining QFD and SPC can lead to improved product quality by translating customer requirements into engineering characteristics and monitoring process performance statistically. The approach also allows for dynamic updates in QFD during production based on customer feedback, thereby enhancing the quality of delivered products and increasing customer satisfaction. SPC, in this context, plays a vital role in identifying significant deviations or abnormalities in product characteristics and in maintaining key process parameters by deriving from updated customer requirements in a stable and controlled state over the long term. This ensures that products meet the desired performance quality as specified by the customer. Therefore, these combined methods are highly applicable for improving product quality in metal MSMEs.

This article aims to explore the extent to which methods such as Fuzzy-KANO, Quality Function Deployment (QFD), and Statistical Process Control (SPC) have been developed by researchers and how they can be utilized by SMEs to support sustainable product development. To achieve this, a systematic literature review was conducted to examine the potential of these methods in assisting metal SMEs in enhancing

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product development, reducing product defects, and maintaining product quality—ultimately contributing to the sustainability of their businesses.

1.1 *Micro, Small, and Medium Enterprises (MSMEs)*

Micro, Small, and Medium Enterprises (MSMEs) are types of productive businesses owned by individuals or business entities that meet certain criteria based on the number of workers, annual turnover, and assets. In Indonesia, the classification of MSMEs refers to Law No. 20 of 2008, which divides them into: [10]

a. Micro Business: Assets ≤ Rp 50 million, turnover ≤ Rp 300 million per year.
b. Small Business: Assets > Rp 50 million–500 million, turnover > Rp 300 million–2.5 billion per year.
c. Medium Business: Assets > Rp 500 million–10 billion, turnover > Rp 2.5 billion–50 billion per year.

Metal SMEs refer to small and medium enterprises engaged in metal-based manufacturing activities, including casting, machining, fabrication, and assembly of metal products. Their product range typically includes automotive components, agricultural tools, household appliances, and light construction materials.

Metal SMEs have a strategic role in the Indonesian economy and manufacturing industry, including. [11]:

1. Local Component Suppliers:
   Metal SMEs supply components or spare parts for the automotive, agricultural, and household appliances sectors. This helps reduce dependence on imports and strengthens the local supply chain.
2. Labor Absorber:
   This sector absorbs a lot of labor, especially in areas with metal industry centers such as Tegal, Ceper (Klaten), and Sidoarjo.
3. Driver of Local Innovation:
   Metal SMEs often modify and adapt products to meet the specific needs of local consumers, thus supporting innovation based on market needs.
4. Regional Economic Equity:
   Many metal SMEs develop outside large industrial centers, thus playing a role in the equitable distribution of national economic development.

According to data from the Ministry of Cooperatives and SMEs in 2021 [12], MSMEs are one of the most important pillars in the Indonesian economy. Currently, the number of MSMEs has reached 64.2 million with a contribution to GDP of 61.07 percent or 8,573.89 trillion rupiah. The contribution of MSMEs to the Indonesian economy includes the ability to absorb around 117 million workers or 97 percent of the total workforce, as well as collecting up to 60.4 percent of total investment.

1.2 *Fuzzy Logic Method*

Fuzzy logic is a mathematical approach that enables the handling of uncertainty and imprecision in data, decision-making, and human judgment. Unlike classical (binary) logic, which only recognizes two absolute values (true or false), fuzzy logic allows for degrees of truth that range continuously between 0 and 1.

Fuzzy logic is used to handle uncertainty and subjectivity in decision-making, especially in the context of customer preferences and uncertain production conditions. In the manufacturing industry, fuzzy logic helps in designing adaptive and flexible control systems. For example, a study by Elamvazuthi et al [13] Applied fuzzy programming techniques to production planning in the textile industry, showing increased efficiency in production scheduling. In the application of Fuzzy Logic in Handling Data Uncertainty, fuzzy logic can be applied in the context of optimizing production processes in metal SMEs. Fuzzy logic has several significant applications to overcome data uncertainty and decision complexity. Some of the main applications of fuzzy logic in this context are:

a. Production Planning and Scheduling
   In production planning, there is often uncertainty regarding market demand, production cycle time, or raw material availability. Using fuzzy logic, we can estimate the degree of uncertainty in each variable and generate a more flexible and realistic schedule. For example, in a fuzzy-based production planning model, parameters such as "sufficient raw material quantity" or "fast turnaround time" are not only assessed in terms of exact numbers, but through membership degrees that reflect uncertainty.
b. Quality Control and Defect Detection
   - Quality control in metal casting or

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machining processes is often affected by factors that cannot be measured precisely, such as varying temperature or material hardness. Fuzzy logic is used to assess product quality by combining various uncertain variables (such as "hot enough" or "few defects").

- By using fuzzy systems, decisions to accept or reject products can be made based on more adaptive quality constraints, rather than just rigid threshold values.

c. Customer Needs Assessment and Classification

In the metal industry, understanding customer needs is often subjective and not quantitatively measurable. By applying fuzzy logic, companies can more accurately classify customer needs into categories (e.g., “very important”, “important”, “moderately important”) based on membership degrees.

1.3 *Application of Fuzzy Logic in Measuring Customer Perception and Qualitative Preferences*

Customer perceptions and qualitative preferences are important factors in determining the quality of products and services. However, these perceptions are often subjective and not easily measured quantitatively, especially in the context of the manufacturing industry. This is where fuzzy logic can play a very important role. Fuzzy logic allows companies to deal with uncertainty and ambiguity in subjective qualitative data, such as customer satisfaction levels, product quality desires, and features that are considered important by customers. [14] for measuring customer perception and qualitative preference assessment.

1.4 *Implementation in the Kano Model System with Fuzzy Logic*

The Kano model is used to identify and classify product attributes based on customer preferences, which are divided into three main categories: must-be, one-dimensional, and attractive. Using fuzzy logic, this system can help measure the degree of customer satisfaction with various product attributes and adjust for uncertainty or imprecision in their preferences. For example, an attribute such as “delivery speed” can be assigned a fuzzy membership degree that describes whether the delivery meets customer expectations (e.g., fast, very fast, or slow) based on the feedback received. [15] Their research is used to develop more realistic and accurate decision models in the context of product development by combining Kano fuzzy with other methods such as FMEA and MCDM. In other research, [16] Fuzzy Kano and Fuzzy Axiomatic Design (FAD) Integration: The authors propose a new methodological framework for New Product Development (NPD) by integrating fuzzy-based Kano model and FAD. The goal is to improve the accuracy of product attribute classification based on customer satisfaction and company expectations under conditions of uncertainty. This article concludes that the innovatively developed Fuzzy Kano method combined with FAD can be a powerful and reliable tool in new product development.

1.5 *Implementation in Quality Function Deployment (QFD) with Fuzzy Logic*

Quality Function Deployment (QFD) is a tool used to translate customer needs and preferences into technical product requirements. Fuzzy logic can be used to measure and analyze uncertain or inconsistent customer preference data, providing more flexibility in prioritizing product improvements or innovations. For example, if customers express that “product strength” is very important but with variations in their ratings, fuzzy logic allows the conversion of qualitative data into information that is more easily processed in product planning. [17] In their research, they conclude that the developed Fuzzy-QFD approach is a superior design tool in dealing with uncertainty, highly relevant for the design of human-centered metaverse-based interactive systems. In other research [18], This article concludes that the Fuzzy QFD and ARIZ-based approaches can produce innovative and realistic product designs to meet the needs of modern households with high complexity.

1.6 *KANO Model*

The Kano Model is a tool used to classify and analyze customer needs based on how each of these needs affects customer satisfaction. Developed by Noriaki Kano in 1984, the model helps companies identify and prioritize product features that are important to customers. It is particularly relevant in product innovation, as it allows the development of products that not only meet basic expectations but can also create higher

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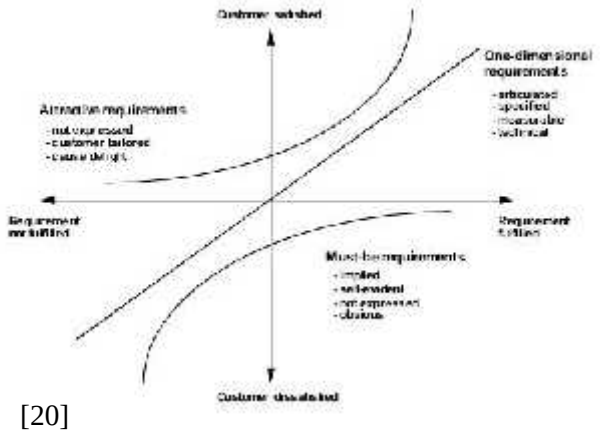
levels of customer satisfaction and loyalty. [19]. The Kano model classifies customer needs into five categories: must-be, one-dimensional, attractive, indifferent, and reverse. This classification helps in understanding customer priorities and designing products that meet or exceed their expectations. Integrating the Kano model into QFD allows companies to focus on product features that have the greatest impact on customer satisfaction.

Zhao et al. [20] reported that their case study demonstrated that the combined Kano model with Attention-BiLSTM achieves high prediction accuracy, enabling companies to develop product innovation strategies that are more responsive to evolving market needs. Prihono and Indra [21]said, Fuzzy logic is one technique of MCDM which is commonly used for affirmation of decisions.



[20]

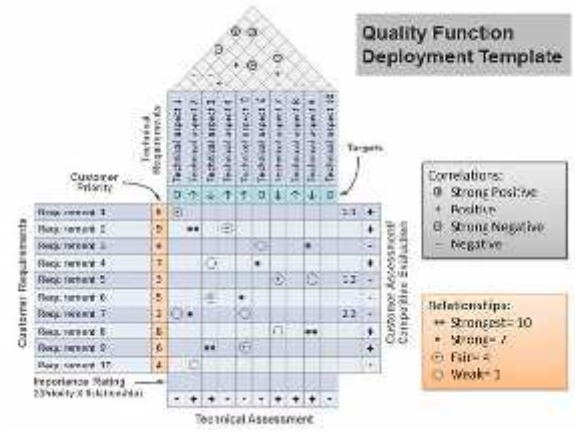
Figure 1. KANO Model

Xin Yang et al. [21] Conducted a study concluding that the Kano model can be effectively used to determine service priorities based on their impact on elderly satisfaction. The findings provide both theoretical and practical guidance for policymakers and public sports service providers to develop more targeted, responsive, and needs-oriented services for the elderly, thereby supporting the promotion of healthy aging.

1.7 *Quality Function Deployment (QFD)*

The Quality Function Deployment (QFD) method was first developed by Yoji Akao in Japan during the 1960s and has since been widely applied in the automotive, electronics, and various other manufacturing industries. In the context of metal SMEs, QFD can be utilized to align production processes with customer expectations, thereby producing products with higher added value that are more competitive in the market. Santoso et al. [22] stated in their research that QFD, whether applied independently or in integration with other methods, has proven to be a highly effective tool for driving sustainable product innovation in the agro-industrial sector. They further recommend expanding the application of QFD to micro and medium enterprises and improving strategies to enhance the success of its implementation.

Ishak et al. [23] revealed that QFD is employed to translate customer requirements into technical characteristics, while AD (Analytical Design) is utilized to develop design solutions that optimally meet functional requirements. Their results indicate that the most critical technical attributes in the product design are product composition, frame strength, and measurement duration. The newly developed design exhibits a lower information complexity value compared to the current design, suggesting that it is more efficient and better aligned with user needs.



[24]

Figure 2. QFD (Quality Function Deployment) Template

Quality Function Deployment (QFD) is implemented in the development of the mechanical engineering curriculum by making Course Learning Outcomes (CLOs) as Voice of the Customer (VoC) and ABET Student Outcomes as Technical Requirements (HOWs) to meet ABET accreditation standards. [24]. In another study [25], A combination of QFD and Fuzzy MCDM has been conducted. Where a product development method has been developed with Fuzzy Quality Function Deployment (Fuzzy QFD) to identify customer needs and technical characteristics, and Fuzzy Multi-Criteria Decision Making (Fuzzy MCDM)

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to evaluate and select the best product prototype systematically, taking into account the uncertainty of customer data and the complexity of technical decisions.

1.8 *Integration of Fuzzy, KANO, and QFD*

Research related to the integration of Fuzzy, KANO, and QFD has been carried out, such as [26], The implementation of the models, it will be tested for the transportation of persons with disabilities. The study started with the identification of Voice of Customer (VoC) by employing the Kano method, that is, by administering the functional and dysfunctional questionnaire to the respondent. The next step was to use the Fuzzy method to reduce the subjectivity of respondents' answers. Each of the attributes was then classified into the Kano categories: must be, one-dimensional, attractive, and indifferent. To design the service system, the QFD was employed. Based on the result of QFD analyses, there were eleven criteria for the service needs of VoC and 21 attributes of technique responses used to design the service system.

In another study, a two-stage integrative model was developed that combines fuzzy sets, the Kano model, and Quality Function Deployment (QFD) to identify critical factors in air conditioning (AC) product innovation during the COVID-19 pandemic, focusing on the air purification function. This model combines multi-actor preferences (consumers, designers, and manufacturers), classifies demand through the Kano model, and then transforms it into technical property indices using QFD. This study shows that the approach can handle linguistic uncertainty and product design complexity more accurately, and generate product innovation priorities that are more realistic and responsive to market needs and technological developments. [27]. The Fuzzy QFD method has proven to be effective in the supplier selection process, as it can manage uncertainty and subjectivity in evaluations, resulting in more accurate and structured decisions compared to conventional approaches. [28]. In another study, researchers identified 11 attributes of unmet patient needs in a private hospital in Bandung. By integrating Servqual, Kano, and two-stage QFD methods, they developed 21 critical recommendations to enhance hospital service quality and better meet patient expectations. [29]. This research combined Servqual, Fuzzy, Kano, and QFD methodologies, demonstrating that such multi-method integrations are feasible and effective. Collectively, these studies indicate that integrating various methods can be successfully implemented to improve decision-making and service quality.

1.9 *Statistical Process Control (SPC)*

Statistical Process Control (SPC) is a quality control method that uses statistical tools to monitor and control the production process. Tools such as $\bar{X}$ and R control charts are used to detect variations in the production process and ensure that the process remains within established control limits. The application of SPC helps in identifying quality problems early and preventing defective products from reaching customers. [30]. Statistical Process Control (SPC) provides a systematic, statistically based approach to monitoring, controlling, and improving production processes to stay within the desired specification limits. SPC aims to detect process variations early, so that corrective action can be taken immediately before producing defective products. SPC is not only used for final product inspection, but also to control quality throughout the production process by observing data in the form of graphs and statistics. Where it has the Main Tools in SPC (Seven Tools of Quality).

1.10 *Combination of SPC and QFD in SMEs*

The combination of QFD and SPC in the SME industry has not been widely found, perhaps because SME resources are limited, or researchers are not interested in researching it. The research that is often found related to SMEs is still on the use of SPC or SMEs with QFD. [31], Their paper highlights the importance of integrating SMEs (Small and Medium Enterprises) into the aerospace industry supply chain and identifies a number of key factors for the success of such integration. Through an exploratory study of SMEs in this sector. [32] In other studies, the new product development (NPD) process in SMEs is different from that in large companies, characterized by informal processes, limited resources, and the need for technological support. Collaboration with external parties, the use of tools such as QFD, and an adaptive design approach are essential. Effective NPD process design in SMEs must consider aspects of product design, innovation collaboration, and appropriate tools and techniques. In another study, it was

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highlighted that the use of personal protective equipment (PPE) in SMEs is still low, which is related to the low level of knowledge, attitude, and safety culture of workers. This study shows that the absence of adequate supervision and legal regulation in small industries is the main factor in the low use of PPE. Increased supervision, occupational safety training, and expansion of labor laws, especially for SMEs, are recommended in order to significantly increase the use of PPE and reduce the risk of work accidents [33].

However, research using QFD and SPC for the manufacturing industry already exists. Like [9]. The combination of Quality Function Deployment (QFD) and Statistical Process Control (SPC) methods enables organizations to systematically transform customer requirements into product design and production processes, and ensure the stability and quality of output through continuous statistical monitoring. This approach enhances customer satisfaction by enabling dynamic updates to their needs based on feedback, thereby driving continuous improvement in the quality and competitiveness of the organization. Then, Statistical Process Control (SPC) and Quality Function Deployment (QFD) methods have proven to be the most impactful quality techniques in the industrial engineering domain, especially in production planning and control. Through the AHP approach, this study shows that the application of quality engineering techniques can increase productivity and sustainability by approximately 70%, making it an effective strategy to improve overall industrial performance. [34]. For the implementation of the Kano-QFD approach, it has been proven effective in increasing the intention to transfer learning in technology-based SMEs, especially through increasing one's abilities and the relevance of training materials. This program helps SMEs design product strategies that suit customer needs and can be applied across industries. [35].

II. RESEARCH METHODOLOGY

This research is used as an SLR if SMEs need to implement approaches to ensure the sustainability of their business. For this reason, it is necessary to apply appropriate methods so that SMEs can be competitive. Approaches that can be applied include: SPC, QFD, and Fuzzy-KANO.

The initial research began by identifying relevant search terms in databases such as Publish or Perish, which are known for their extensive coverage of a wide range of material. Nowadays, to survive in the “publish or perish” era, scientific publishers must adopt innovative publishing models, establish collaborations between institutions, and enhance researchers’ understanding of global scientific publishing trends and strategies [36]. However, the study shows that Scopus has experienced exponential growth since 1900 in terms of the number of articles, journals, field coverage, and the author country of origin. A significant increase occurred after the launch of Scopus in 2004. The use of abstracts in articles has also increased dramatically, from only 1% of articles having long abstracts in 1900 to 95% in 2020. In addition, international contributions to publications have become more even, with the initial dominance by the US and Germany being replaced by China and India in 2020 [37].

The literature search in this study used databases from Google Scholar, Crossref, and Scopus. Where researchers use the Scopus database because its scope is wider and the information related to the article is more structured to be processed with Bibliometrix [38]. And [39] also using Scopus using the keywords: "Optimization of Production Processes in Micro, Small and Medium Metal Enterprises" OR "SMEs" OR "SMEs Metal" AND "SPC" OR "Statistics Process Control" OR "QFD" OR "Quality Function Deployment". The screening process was conducted by assessing the appropriateness of both the abstract and the title in relation to the study topic. Articles that passed to the next stage were screened in full text, containing discussions on using SMEs, SPC, and the QFD method. In this screening, Open Refine is used to view the results from the database, which is continued with a worksheet to ensure the completeness of the data. The VOS Viewer generates a visual display of bibliographic materials using custom input data. The search terms represent the inclusion criteria and are closely linked to the study's objectives, scope, limitations, and areas for further exploration. Moreover, only English-language original articles were taken into account.

This study is an applied research aimed at developing a risk-based calibration system model in the copper foil industry using a quantitative approach. This approach was selected because the

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problems addressed are practical in nature and related to evaluating the actual condition of measurement instruments. The study integrates two main methods: Fuzzy Failure Mode and Effects Analysis (Fuzzy FMEA) for risk assessment and Measurement System Analysis (MSA) with Gauge Repeatability and Reproducibility (GRR) for evaluating measurement system capability. This research also adopts risk-based thinking as recommended in ISO 9001:2015 and ISO/IEC 17025:2017, which emphasizes the importance of risk identification and control throughout the measurement process. Therefore, this study develops a calibration system that is not solely time-based but also adjusted according to the actual performance and risk level of each instrument.

2.1 *Integration of Small and Medium Enterprises (SMEs), SPC, and QFD*

The integration of SMEs with both SPC and QFD has not been extensively explored in previous studies. Existing research mostly focuses on the integration of SMEs with either SPC or QFD separately. As illustrated in Figure 3, a total of 562 records were retrieved from Google Scholar, Crossref, and Scopus databases. After an initial screening, 475 records were excluded, leaving 87 for further processing. However, among these 87 records, 31 were found to be books, reports, or theses and were therefore excluded from the analysis. Consequently, only 56 journal articles were examined in detail. Of these, 35 full-text articles were accessible, as many others required payment for access.

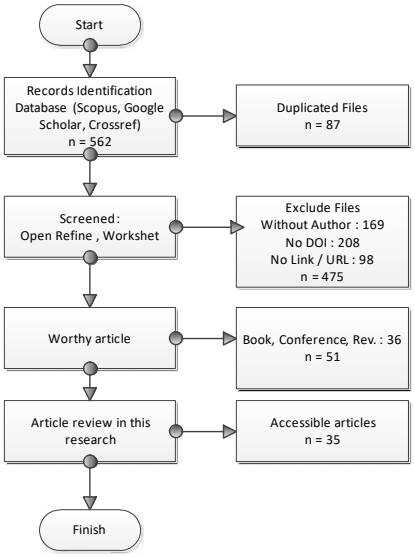

Figure 3. Flow Chart of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis)

Thus, this study utilized 35 articles, as shown in Figure 3, which were successfully downloaded and included in the reference list.

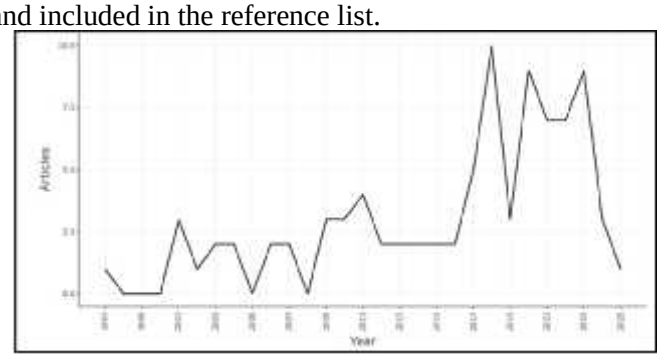

Figure 4. Annual Scientific Production

As shown in Figure 4, research development on the integration of Small and Medium Enterprises (SMEs), SPC, and QFD remains limited, with publications only beginning to emerge around early 2017.

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	1997:2025
Sources (Journals, Books, etc)	69
Documents	87
Annual Growth Rate %	0
Document Average Age	9.02
Average citations per doc	12.37
References	3409
DOCUMENT CONTENTS	
Keywords Plus (ID)	489
Author's Keywords (DE)	268
AUTHORS	
Authors	260
Authors of single-authored docs	3
AUTHORS COLLABORATION	
Single-authored docs	3
Co-Authors per Doc	3.28
International co-authorships %	12.64
DOCUMENT TYPES	
article	51
book chapter	2
conference paper	31
conference review	2
review	1

Figure 5. Main Information from the Bibliometrix Output

Furthermore, the data was processed using Bibliometrix, as shown in Figure 5. The analysis identified a total of 87 documents, spanning the period from 1997 to 2025. Among these, 51 are journal articles, while the remaining 36 consist of books and conference papers. The main information also revealed a total of 260 contributing authors and 489 keywords.

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Figure 6. Distribution of Document Groups Generated by Bibliometrix

As shown in Figure 6, Bibliometrix grouped the documents into eight categories, as detailed in Table 1.

Table 1. Group Documents Based on Bibliometrix

Label	Group	Freq.
product design; quality function deployment; supply chains	1	11
quality function deployment	2	5
competitiveness; education and training	3	4
decision making; fuzzy sets; sustainable development	4	4
statistical process control; quality control	5	4
electric energy storage; magnetic storage; pancake coils	6	3
quality function deployment; analytical hierarchy process; balanced scoreboard (BSC)	7	5
analytical hierarchy process; automotive industry; automotive supplier industry	8	2

Table 1 indicates that Group 1, which comprises the largest number of research topics, includes themes such as product design, quality function deployment, and supply chains.

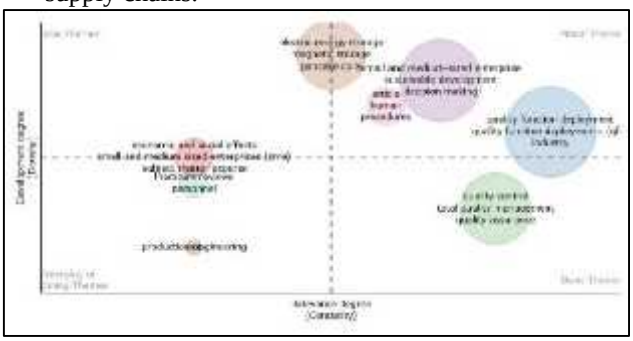

Figure 7. Thematic Map Based on Bibliometrix

Based on the thematic mapping analysis results using Bibliometrix, as shown in Figure 7, four categories of research themes were identified, representing the strategic position of each topic within the scientific landscape. Themes located in the motor themes quadrant, such as small and medium-sized enterprises, sustainable development, decision making, and procedures, exhibit high levels of both relevance and development. This positioning indicates that these themes play a central and dynamic role in the field, serving as the main focus of current literature. Their dominance reflects conceptual and methodological maturity, as well as significant potential to shape future research directions. Conversely, themes such as quality control, total quality management, and quality assurance fall in the quadrant of the basic themes. Although highly relevant to the field, these themes have shown limited development. This suggests a need to update theoretical frameworks and integrate contemporary issues to prevent stagnation. In contrast, themes like electric energy storage and pancake coils are categorized as niche themes. These show high development but possess limited relevance, typically representing highly specialized and in-depth areas with significant contributions within narrow applications or specific scientific communities. Themes, including production engineering, personnel, and subject matter experts, are positioned in the emerging or declining themes quadrant, characterized by low relevance and development. This may indicate that these themes are either in the early exploratory stages or beginning to be abandoned by the scientific community. Additionally, several transitional themes, such as economic and social effects, literature reviews, and small and medium-sized enterprises (SMEs), are located at the center of the map. This positioning highlights their potential either to evolve into motor themes with sustained research attention or to decline without adequate scientific support. Overall, this thematic mapping provides a strategic overview of the structure and dynamics of the field of study being analyzed. The insights gained are valuable not only for tracking research trends but also for guiding future research directions by identifying emerging themes, relevant yet underdeveloped themes, and themes that require revitalization to sustain their contribution to scientific advancement. Next, a summary of themes related to SMEs, SPC, and QFD is shown in Table 2.

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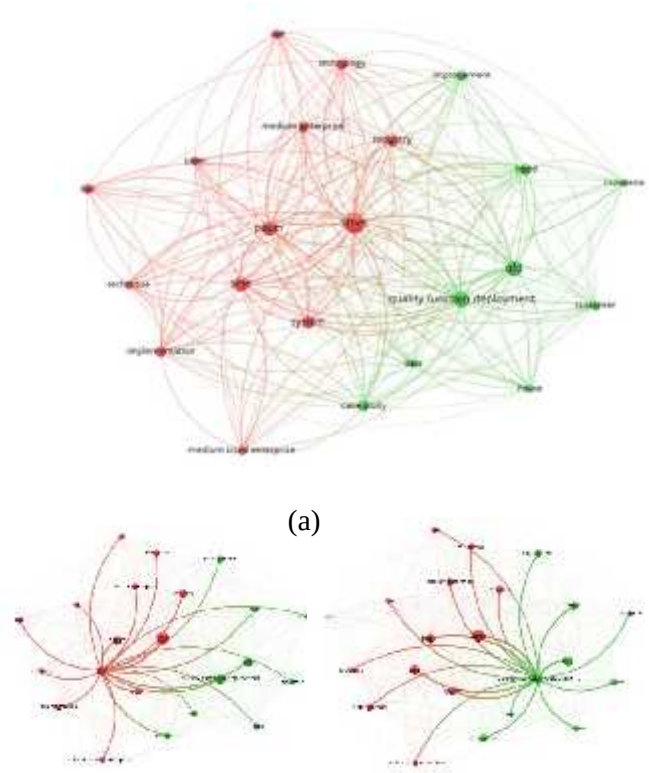
Table 2. Summary of themes for SMEs, SPC, and QFD-related articles

Topic	Description	Authors
SPC and SMEs Integration	Digital technologies play a crucial role in building antifragility in SMEs, enabling them not only to survive crises such as COVID-19 but also to grow stronger through these challenges.	[40]; [41];
QFD and Digital Transformation	Examining the integration of Quality Function Deployment (QFD) in industrial digital transformation strategies.	[42];
QFD and Industry 4.0	Examining the application of Quality Function Deployment (QFD) within the Industry 4.0 technology framework to enhance product quality.	[42];
Hybrid QFD–AHP/KANSEI	Developing a hybrid approach combining Quality Function Deployment (QFD) and the Analytical Hierarchy Process (AHP) for design decision-making.	[43]; [44];
Hybrid QFD–Kano	Integrating QFD and the Kano Model in product design that focuses on SME customer needs.	[45]; [46]; [47];
QFD and Customer Satisfaction	The relationship between Quality Function Deployment (QFD) methods and customer satisfaction in product development.	[48]; [49]; [50]
SPC and QFD for Customer Satisfaction	Evaluating the relationship between Statistical Process Control (SPC) and Quality Function Deployment (QFD) implementation and customer feedback in quality improvement.	[51]

Table 3. Potential Directions for Future Research

Aspect	Findings	GAP	Opportunity
QFD and Quality	Important but underdeveloped	Low integration and the need for new approaches	Fuzzy-Kano-QFD specifically for SMEs
SMEs & Socio-Economic	Not strongly connected to quality themes	Still developing	Relevance of QFD in the local context of SMEs
Sustainability & Decision Making	Advanced but not integrated into QFD	Lack of connection between themes	QFD as a decision-making tool for sustainability
Production Engineering	Not specific	Not closely or linked to quality	Connect QFD with production processes & SPC.

In Table 3, we can see several research opportunities that still need to be explored.



(a) (b) (c)

Figure 7. Visualization of keyword usage frequency. Network visualization by VOSviewer, the relationship between frequently used keywords in SMEs, SPC, and QFD.

In Figure 7, part (a) presents a VOSviewer network visualization that includes terms related to SMEs, Statistical Process Control (SPC), and Quality Function Deployment (QFD), showing the overall network formed from all related documents. In part (b), the network specifically illustrates the relationship between SMEs and Statistical Process Control (SPC). There are no connections linking this network to Quality Function Deployment (QFD), indicating a lack of direct association. Similarly, part (c) shows the network between SMEs and Quality Function Deployment (QFD), where no visible connections to Statistical Process Control (SPC) are found. Upon closer examination of the enlarged VOSviewer visualization, it becomes clear that there is no relationship or network connection between Statistical Process Control (SPC) and Quality Function Deployment (QFD). The networks appear disconnected, highlighting the gap in the literature that integrates these three elements.

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III. RESULTS AND DISCUSSION

The limited number of literature reviews on the subject of Metal SMEs, Statistical Process Control (SPC), and Quality Function Deployment (QFD) integrated with the Fuzzy-KANO model indicates that no comprehensive study has been conducted. This condition is very different when compared to studies on the metal industry with SPC or industries that apply Quality Function Deployment (QFD) separately. The role of Quality Function Deployment (QFD) in the manufacturing industry has been previously studied, and even more extensively in the service industry, as the Quality Function Deployment (QFD) approach effectively captures customer needs and translates them into technical responses aimed at fulfilling those needs. This process is expected to enhance customer satisfaction and, ultimately, support the sustainability of the business.

Thus, the integration of several methods into QFD, such as Fuzzy-KANO, along with the incorporation of SPC to address challenges in Metal SMEs, remains novel and holds significant potential to provide effective solutions for the issues faced by these enterprises. This integrated approach can contribute substantially to the sustainability of Metal SMEs. Furthermore, this potential is reinforced by previous studies that have successfully combined various methods in industries beyond Metal SMEs. Research on SPC and SMEs Integration by Vincenzo Corvello et al., [40]; Radicic & Petkovic, [41] gives the idea that digital technologies play a crucial role in building antifragility in SMEs, enabling them not only to survive crises such as COVID-19 but also to grow stronger through these challenges. SPC and QFD for Customer Satisfaction by Kelblerová & Vykydal, [51], gives an idea that evaluating the relationship between Statistical Process Control (SPC) and Quality Function Deployment (QFD) implementation and customer feedback in quality improvement. Hybrid QFD–Kano by Shanmugaraja, et al., [45]; Pujianto et al., [46]; and Neira-Rodado et al., [47] gives an idea that integrating Quality Function Deployment (QFD) and Kano Model in product design that focuses on SME customer needs. Quality Function Deployment (QFD) and Customer Satisfaction by Ce, et al., [48]; Zhang et al., [49] and Prihono & Nurcahyanie, [26] give an idea of the relationship between Quality Function Deployment (QFD) methods and customer satisfaction in product development.

IV. CONCLUSION

The integration of Statistical Process Control (SPC) and Quality Function Deployment (QFD) approaches with Fuzzy-KANO provides a systematic methodology that effectively incorporates customer needs and expectations into the product design and development processes within SMEs. This study finds that combining Quality Function Deployment (QFD) with Fuzzy-KANO yields better outcomes than conventional Quality Function Deployment (QFD) techniques by incorporating additional factors relevant to the SMEs sector, such as environmental sustainability, regulatory compliance, and supply chain considerations. Additionally, Statistical Process Control (SPC) supports product quality assurance by continuously monitoring the production process and minimizing the occurrence of defects.

However, the integration of Quality Function Deployment (QFD) with various supporting methods remains an area that requires further comprehensive research, particularly as part of advancing engineering applications. This study explores an integrated methodology combining Fuzzy-KANO, Quality Function Deployment (QFD), and Statistical Process Control (SPC) within the context of Metal SMEs, with a focus on the effectiveness of this approach. Furthermore, the study highlights sustainability as a critical factor for Metal SMEs and examines its role in the application of the integrated Statistical Process Control (SPC) and Quality Function Deployment (QFD) approach enhanced by Fuzzy-KANO.

The results of this study indicate that, over the past decade, there has been a fluctuating trend in the number of publications related to the application of SPC and QFD in SMEs, particularly in the context of sustainability-oriented products. Research activity peaked in 2017 and 2023, with 6 publications in 2017 and 9 in 2023. While studies exploring the relationship between SPC and SMEs, as well as between SMEs and QFD, are available, there is a notable absence of research that directly integrates all three elements: SMEs, SPC, and QFD. This highlights the need for further research that explicitly connects these three components in a unified framework. Based on the findings of this review, several potential

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directions for future research are identified, including: (a) the integration of Fuzzy-Kano and QFD specifically tailored to the characteristics and needs of SMEs, particularly in local contexts; (b) the utilization of QFD as a decision-making tool to support sustainability initiatives within SMEs; and (c) the integration of QFD with production processes and Statistical Process Control (SPC) to enhance overall product quality and operational efficiency.

- Authors' contribution
  All authors contributed equally to the preparation of this article.
- Declaration of competing interest
  The authors declare no conflicts of interest.
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- Data availability
  The data that support the findings of this study are available from the corresponding author upon reasonable request.
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REFERENCES

[1] S. Munthe, "www.kemenkeu.go.id," 27 June 2023. [Online]. Available: https://djpb.kemenkeu.go.id/kppn/lubuksikaping/id/data-publikasi/artikel/3134-kontribusi-umkm-dalam-perekonomianindonesia.html.

[2] R. S. Astuti, "www.kompas.id," 21 August 2023. [Online]. Available: https://www.kompas.id/baca/nusantara/2023/08/19/industri-logam-ngingas-berkembang-ditengah-tantangan-yang-kian-beragam-feature.

[3] J. Debora, "Perancangan model matematis QFD-kano dalam menentukan target karakteristik teknis rak sepatu," WIdya Mandala Catholic University , Surabaya, 2017.

[4] L. O. G. G. G. M. d. G. P. F.L. Lizarelli, "Integration of SERVQUAL, Analytical Kano, and QFD Using Fuzzy Approaches to Support Improvement Decisions in an Entrepreneurial Education Service," *Applied Soft Computing*, pp. 1-15, 2021.

[5] M. A.-H. d. N. Jin, "Smart Product Design Process through the Implementation of Fuzzy Kano, AHP, DEMATEL, and QFD," *Applied Sciences*, pp. 1-28, 2020.

[6] T. E. G. B. Cengiz Kahraman, "A fuzzy optimization model for QFD planning process using analytic network approach," *European Journal of Operational Research*, pp. 390-411, 2011.

[7] A. Z. Fakih, "Pengendalian Kualitas pada Proses Produksi untuk Meminimalisir Cacat Produk Roti Gulung dengan Metode Statistical Process Control (SPC)," Universitas Islam Sultan Agung, Semarang, 2023.

[8] C. M. Ignatio Madanhire, "Application of Statistical Process Control (SPC) in Manufacturing," *Procedia CIRP*, pp. 580-583, 2016.

[9] D. V. Michaela Kelblerová, "Application of QFD and SPC Methods in the Processes of Design and Products," in *International Carpathian Control Conference (ICCC)*, Ostrava, 2011.

[10] U. N. 20/2008, 2008. [Online]. Available: https://ojk.go.id/waspada-investasi/id/regulasi/Documents/UU_20_Tahun_2008_Usaha_Mikro_Kecil_dan_Menengah.pdf.

[11] M. Junaidi, "https://djpb.kemenkeu.go.id," 4 11 2024. [Online]. Available: https://djpb.kemenkeu.go.id/kppn/curup/id/data-publikasi/artikel/2885-umkm-hebat,-perekonomian-nasional-meningkat.html#:~:text=UMKM%20merupakan%20salah%20satu%20pilar,senilai%208.573%2C89%20triliun%20rupiah..

[12] D. Damayanti, "https://www.pajak.go.id," 26 11 2024. [Online]. Available:

p-ISSN 2622-2027
DOI: https://doi.org/10.36456/tibuana.9.02.11607 *e*-ISSN 2622-2035

https://www.pajak.go.id/id/artikel/umkm-coretax-dan-rasio-pajak#:~:text=Sebagai%20gambaran%2C%20berdasarkan%20data%20Kementerian,senilai%208.573%2C89%20triliun%20rupiah

[13] I. Elamvazuthi, T. Ganesan and P. Vasant, "Application of a Fuzzy Programming Technique to," *International Journal of Computer Science and Information Security,* pp. 238-242, 2009.

[14] Z. X. H. Wu, "Fuzzy Logic in Decision Support: Methods, Applications and Future," *INTERNATIONAL JOURNAL OF COMPUTERS COMMUNICATIONS & CONTROL,* pp. 1-28, 2021.

[15] S. Z. M. T. Y. L. Jia Shao, "Combining fuzzy MCDM with Kano model and FMEA: a novel," *Annals of Operations Research,* pp. 725–765, 2024

[16] C.-M. Yang, S. Li, K.-S. Chen, M. Li and W. Lo, "A Methodological Framework for New Product Development in Fuzzy Environments," *Journal Systems,* pp. 1-17, 2024.

[17] Q. Fu, Q. Liu, X. Lu, T. Hu, Y. Wang, and J. Pan, "Interval-valued spherical fuzzy quality function deployment methodology: Metaverse collaborative system design application," *Engineering Applications of Artificial Intelligence,* pp. 1-22, 2024.

[18] Z. Liu, X. Liang, X. Chen, and X. Wen, "Design of a sweeping robot based on fuzzy QFD and ARIZ algorithms," *Heliyon,* pp. 1-26, 2024.

[19] E. Sauerwein, K. Matzler, F. Bailom, and H. Hinterhuber, "The Kano Model: How to Delight Your Customers," in *International Working Seminar on Production Economics,* Innsbruck, Austria, 1996.

[20] J. Zhao, Y. Huang, J. Feng, W. Xie and K. Jain, "Fusion of KANO theory and Attention-BiLSTM models for user demand analysis and trend prediction," *Information Fusion,* pp. 1-10, pp. 1-10, 2025

[21] Xin Yang, Zimiao Leng, Changning Ma, and Guanghui Yang, "Demand analysis of public sports service for older adults using Kano model," *Frontiers in Public Health,* pp. 1-11, 2025,

[22] I. Santoso, H. Rau, A. Choirun, H. C. Aprilianto, K. Lestari, S. A'yuniah, and O. W. Kusumaningtyas, "Application of QFD in sustainable new product development in the agro-industrial sector: a systematic literature review," *INTERNATIONAL JOURNAL OF SUSTAINABLE ENGINEERING,* p. 926–944, 2024.

[23] A. Ishak, R. Ginting, and S. Siallagan, "Application of quality function deployment (QFD) and axiomatic design method for product design: case study compost waste product," *Journal of Achievements in Materials and Manufacturing Engineering,* pp. 31-41, 2024.

[24] F. Francis, "Engineering Approach with Quality Function," *American Journal of Mechanical Engineering,* pp. 65-70, 2016.

[25] H.-T. Liu, "Product design and selection using fuzzy QFD and fuzzy MCDM approaches," *Applied Mathematical Modelling,* pp. 482-496, 2011

[26] Prihono and Y. D. Nurcahyanie, "Pengembangan Model QFD Berbasis Fuzzy KANO Untuk Jasa Layanan Transportasi Bagi Disabilitas," *Jurnal Teknik WAKTU,* pp. 21-29, 2017.

[27] Y. Yu, C. Li, W. Yang, and W. Xu, "Determining the critical factors of air-conditioning innovation using an integrated model of fuzzy Kano-QFD during the COVID- 19 pandemic: The

p-ISSN 2622-2027
DOI: https://doi.org/10.36456/tibuana.9.02.11607 *e*-ISSN 2622-2035

perspective of air purification," *PLOS ONE*, pp. 1-24, 2021.

[28] M. Bevilacqua, F. Ciarapica and G. Giacchetta, "A fuzzy-QFD approach to supplier selection," *Journal of Purchasing & Supply Management*, p. 14–27, 2006

[29] S. Anastasya and M. L. Singgih, "Evaluasi Service Quality Platform Digital DANA Menggunakan Fuzzy E-ServQual, IPA-Kano, dan QFD," *JURNAL TEKNIK ITS*, pp. 14-19, 2024.

[30] V. Gaspersz, Pedoman Implementasi Program Six Sigma, Bogor: Gramedia, 2002.

[31] A. Castillón Barraza, A. González Angeles, F. Lara Chavez, and I. Mendoza Muñoz, "Tools to Measure the Technological Capabilities of the Aerospace Industry," *Journal of Industrial Engineering and Management*, pp. 769-775, 2018.

[32] M. Iqbal and A. Suzianti, "New Product Development Process Design for Small and Medium Enterprises: A Systematic Literature Review from the Perspective of Open Innovation," *Journal of Open Innovation: Technology, Market, and Complexity*, pp. 1-19, 2021.

[33] A.Hossein Khoshakhlagh, Mahdi Malakoutikhah, JeeWoong Park, M. Dehghani Kodnoueieh, Z. Rafieian Boroujeni, Maryam Bahrami, and Fatemeh Ramezani, "Assessing personal protective equipment usage and its correlation with knowledge, attitudes, performance, and safety culture among workers in small and medium-sized enterprises," *BMC Public Health*, pp. 1-9, 2024

[34] M. K. Gavareshki, M. Abbasi, M. Karbasian, and R. Rostamkhani, "Application of quality engineering techniques in the main domains of industrial engineering," *Journal of Achievements in Materials and Manufacturing Engineering*, pp. 22-40, 2018.

[35] T. N. Agassi, M. Ushada, and A. Suyantohadi, "INDUSTRIAL DESIGN OF KANSEI ENGINEERING-BASED SENSOR FOR INDUSTRY," *Management and Production Engineering Review*, pp. 13-22, 2020.

[36] N. Chirisa and M. Ngoepe, "Publish or perish? Innovative models for scholarly publishing in Zimbabwe," *Information Development*, pp. 1-13, 2024.

[37] M. Thelwall and P. Sud, "Scopus 1900–2020: Growth in articles, abstracts, countries, fields, and journals," *Quantitative Science Studies*, pp. 37-50, 2021.

[38] T. Y. Khaw, A. Amran and A. P. Teoh, "Factors influencing ESG performance: A bibliometric analysis, systematic literature review, and future research directions," *Journal of Cleaner Production*, vol. 448, no. Cleaner Production, pp. 1-15, 2024.

[39] I. Santoso, H. Rau, A. Choirun, H. C. Aprilianto, K. Lestari, S. A'yuniah, and O. W. Kusumaningtyas, "Application of QFD in sustainable new product development in the agro-industrial sector: a systematic literature review," *International Journal of Sustainable Engineering*, vol. 17, no. 1, pp. 926-944, 2024.

[40] Vincenzo Corvello, Saverino Verteramo, Isabella Nocella, and Salvatore Ammirato, "Thrive during a crisis: the role of digital technologies in fostering antifragility in small and medium-sized enterprises," *Journal of Ambient Intelligence and Humanized Computing*, vol. 14, no. Ambient Intelligence and Humanized Computing, p. 14681–14693, 2023.

[41] D. Radicic and S. Petkovic, "Impact of digitalization on technological innovations in small and medium-sized

p-ISSN 2622-2027
DOI: https://doi.org/10.36456/tibuana.9.02.11607 *e*-ISSN 2622-2035

enterprises (SMEs)," *Technological Forecasting & Social Change*, vol. 191, no. 122474, pp. 1-16, 2023.

[42] H. Erbay and N. Yıldırım, "Combined Technology Selection Model for Digital Transformation in Manufacturing: A Case Study From the Automotive Supplier Industry," *International Journal of Innovation and Technology Management*, vol. 19, no. 07, p. 143–157, 2022.

[43]Z. Yu, Y. Liu and K. Kim, "Research on treadmill design based on AHP and mass function expansion," *Journal of Combinatorial Mathematics nd Combinatorial Computing*, vol. 127b, no. 434, pp. 7945--7962, 2025.

[44]T. N. Agassi, M. Ushada, and A. Suyantohadi, "INDUSTRIAL DESIGN OF KANSEI ENGINEERING-BASED SENSOR FOR INDUSTRY," *Management and Production Engineering Review*, vol. 11, no. 1, pp. 13-22, 2020.

[45]M. Shanmugaraja, M. Nataraj and N. Gunasekaran, "Six Sigma project selection via quality function deployment," *International Journal of Productivity and Quality Management*, vol. 10, no. 1, pp. 85 – 111, 2012.

[46]T. Pujianto, E. Mardawati, and S. D. Agustien, "Consumer-Driven Quality Improvement of Tofu Sumedang: An Integrated Kano–QFD Approach for Strategic Product Development," *Jurnal Teknologi dan Manajemen Agroindustri*, vol. 13, no. 2, pp. 200-219, 2024.

[47] D. Neira-Rodado, M. Ortíz-Barrios, S. D. L. Hoz-Escorcia, C. Paggetti, L. No, and N. Fratea, "Smart Product Design Process through the Implementation of a Fuzzy Kano-AHP-DEMATEL-QFD Approach," *Applied Sciences*, vol. 10, no. 5, pp. 1-28, 2020.

[48] W. Ce, L. Xinyue, Y. Fan, and L. Fuhai, "Study on Supermarket Service Quality Optimization Based on Kano-QFD model—Take Beidaihe Ugrant Life Square as an Example," *Academic Journal of Business & Management*, vol. 6, no. 6, pp. 53-60, 2024

[49]Y. Zhang, Zeyu Zheng, and L. Liu, "Design Resource Deployment for Virtual Fitting Applications in the Era of Digital Fashion: An Analysis Based on Kano-QFD," *SAGE Open*, vol. 1, no. 13, p. 1–18, 2024.

[50]M. Kelblerová and D. Vykydal, "Application of QFD and SPC Methods in the Processes of Design and Products Manufacturing," in *International Carpathian Control Conference*, Ostrava, 2011.