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Providing Solutions for Product Quality Development in Iran's Garment Industry with Industry Satisfaction Analysis Based On QFD-MOORA-SWARA Combined Method

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ABSTRACT

Quality Function Deployment (QFD) serves as an essential methodology for enhancing product quality by systematically addressing customer needs and preferences, thereby fostering higher levels of customer satisfaction. Within the clothing industry, aligning production processes with customer expectations for technical quality significantly influences both satisfaction and purchasing behavior. The Iranian clothing market is predominantly import-driven, with Chinese and Turkish products holding substantial market share. This study aims to propose strategies to enhance product quality, thereby supporting domestic competitiveness. Specifically, it investigates the development of product quality in the garment sector through the integration of QFD, Fuzzy SWARA, and Fuzzy MORA techniques. Customer priority indicators for formal and casual shirts were first determined using the Delphi method and subsequently weighted through the Fuzzy SWARA approach. The Fuzzy MORA technique was employed to construct the communication matrix, linking customer needs to technical production indicators. Findings indicate that sewing quality emerges as the most critical technical factor for both formal and casual shirts. Furthermore, the Fuzzy MORA method was applied to analyze the competitive landscape of the Iranian, Turkish, and Chinese clothing industries. The resulting industry satisfaction index demonstrates that Iran ranks second in terms of customer satisfaction within the Iranian men's shirt market.

1. INTRODUCTION

The garment industry in Iran represents a vital sector contributing significantly to employment and economic growth, yet it grapples with challenges related to product quality, customer satisfaction, and competitive positioning

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in global markets [1]. Enhancing product quality is essential for addressing these issues, as it directly influences consumer preferences and industry sustainability [2]. Quality Function Deployment (QFD) has emerged as a structured method to translate customer requirements into technical specifications, facilitating product development in the garment sector [3]. Integrating QFD with Multi-Criteria Decision Making (MCDM) techniques, such as Multi-Objective Optimization on the basis of Ratio Analysis (MOORA) and Step-wise Weight Assessment Ratio Analysis (SWARA), offers a robust framework for prioritizing solutions and analyzing industry satisfaction [4].

Previous studies have demonstrated the efficacy of QFD in identifying key factors affecting garment quality in Iran, such as design, materials, and production processes [5]. For instance, MOORA has been applied to optimize fabric selection in textiles for thermal comfort, showcasing its utility in multi-objective scenarios [6]. Similarly, SWARA has been utilized to weight criteria in sustainable supplier selection within the textile industry, ensuring balanced decision-making [7]. The combination of these methods allows for comprehensive evaluation, as seen in green supplier selection in textile contexts, where AHP-MOORA integration improved environmental and operational outcomes [8].

Furthermore, fuzzy extensions of MOORA enhance handling uncertainty in complex industries like garments [9]. In sustainable product design, hybrid QFD-MADM frameworks have proven effective in incorporating stakeholder requirements [10]. This study proposes solutions for product quality development in Iran's garment industry, employing a QFD-MOORA-SWARA combined method to analyze industry satisfaction and prioritize actionable strategies. This study analyzes Iran's garment industry using an appropriate framework.

The study first confirms the factors based on Delphi. The article proposes using the Swara Fuzzy technique to assess customers' needs. Then, it prioritizes indicators and technical requirements based on the Mora Fuzzy technique and determines the most important technical index on the QFD platform. To calculate the matrix of competitors for the Iranian market, a combination of Fuzzy Sora and Fuzzy Mora is used. It is suggested that industry satisfaction be evaluated based on this matrix.

The objective of this research is to enhance the performance of Iran's garment industry by measuring customer needs and prioritizing technical indicators accordingly. A competitor matrix is then calculated based on Iran's apparel competitors, providing a new approach to measure industry satisfaction.

2. LITERATURE REVIEW

Ensuring product quality in the global garment industry has become increasingly complex due to rapidly changing consumer preferences, globalization of supply chains, and sustainability challenges. To address these concerns, advanced multi-criteria decision-making (MCDM) approaches have been adopted across industries. Among them, Quality Function Deployment (QFD), Multi-Objective Optimization by Ratio Analysis (MOORA), and the Step-wise Weight Assessment Ratio Analysis (SWARA) have shown promising results in aligning customer requirements with technical specifications, weighting decision criteria, and ranking alternatives. While studies applying the integrated QFD–MOORA–SWARA model directly to the garment industry are still limited, applications in other sectors provide valuable insights that can be adapted for product quality improvement in apparel manufacturing.

QFD has long been recognized as a tool to systematically translate customer needs into technical requirements. Yazdani, Chatterjee, and Zavadskas (2017) integrated QFD with MCDM methods for green supplier selection, demonstrating how customer priorities can be transformed into evaluative metrics for sustainable supplier management [11]. Similarly, Akkawuttiwanich and Yenradee (2018) applied a fuzzy QFD approach to manage supply chain operations reference (SCOR) indicators, showing that QFD is effective in performance management under uncertainty [16]. In manufacturing, Devnath et al. (2020) combined QFD and TOPSIS to prioritize lean tools, further reinforcing its value as a decision-support system [17].

The MOORA method has been extensively utilized in diverse industrial contexts. Karande and Chakraborty (2012) employed MOORA for supplier selection, proving its utility in evaluating multiple conflicting criteria [13]. Earlier, Brauers and Zavadskas (2006) introduced MOORA to support privatization in transition economies, emphasizing its robustness in policy decision-making [14]. Additionally, Hafezalkotob (2016) extended MULTIMOORA using Shannon entropy weights for material selection, demonstrating the method’s ability to deal

with high-dimensional decision problems [15]. These findings highlight the adaptability of MOORA/MULTIMOORA to industries with diverse product and supplier evaluation needs, including garments.

SWARA is primarily applied to determine the relative importance of decision criteria. Keršuliene, Zavadskas, and Turskis (2010) first introduced the SWARA method for selecting dispute resolution strategies, showcasing its systematic weight assessment process [18]. Later studies, such as Yücenur and Şenol (2021), applied a sequential SWARA–fuzzy VIKOR approach to lean construction, proving that SWARA effectively captures expert judgment in complex industrial processes [19]. Furthermore, Ansari, Kant, and Shankar (2020) proposed a hybrid fuzzy SWARA–COPRAS framework to mitigate risks in remanufacturing supply chains, further demonstrating its applicability in sustainability-driven environments [20].

Although most of these studies originate outside the garment sector, their insights are transferable. QFD ensures that customer voice is embedded into garment design (e.g., fabric durability, stitching quality, fashion appeal). SWARA provides a robust mechanism to weight attributes such as cost, sustainability, lead time, and flexibility. Finally, MOORA/MULTIMOORA enables objective ranking of suppliers, designs, or quality improvement strategies. Together, the QFD–MOORA–SWARA framework offers a comprehensive methodology to balance subjective preferences and objective criteria, making it highly suitable for product quality development in the global garment industry.

The integration of QFD, MOORA, and SWARA has demonstrated remarkable potential across industries for decision-making in complex, multi-criteria environments. Adopting this integrated model in the garment industry could enable companies to systematically translate consumer needs into technical improvements, prioritize quality attributes, and optimize supplier and production decisions. Ultimately, this approach is expected to improve product quality and enhance industry satisfaction, supporting competitiveness in global apparel markets.

3. RESEARCH METHOD

This research involves field data collection and was conducted based on expert opinions. The expert sample was selected using the snowball method and consisted of 15 individuals.

3.1. Research Process

The research process flows according to the suggested methods in the order of Figure 1.

3.2. Research Process Overview

As illustrated in Figure 1, this study follows a structured sequence of steps. The first step involves identifying the factors that influence customer satisfaction. This is accomplished through a two-stage approach: initially, a comprehensive literature review of prior studies is conducted, followed by expert interviews.

The second step focuses on determining the priority needs of customers to serve as input for Quality Function Deployment (QFD). Basic customer needs are identified through a two-round Delphi process, wherein questionnaires are distributed among experts, allowing them to revise their responses based on aggregated feedback. Subsequently, the identified customer needs are weighted using the Fuzzy SWARA method. Technical production requirements are established through interviews with industry experts. Following this, a relationship matrix is constructed, and the technical indicators are prioritized using the Fuzzy MORA technique.

The sixth step involves assessing the competitors' performance using the Fuzzy MORA prioritization approach. Finally, the industry satisfaction index is presented, reflecting the level of customer satisfaction with each competitor. This index is calculated as the ratio of the final points obtained by each competitor to the maximum possible points achievable.

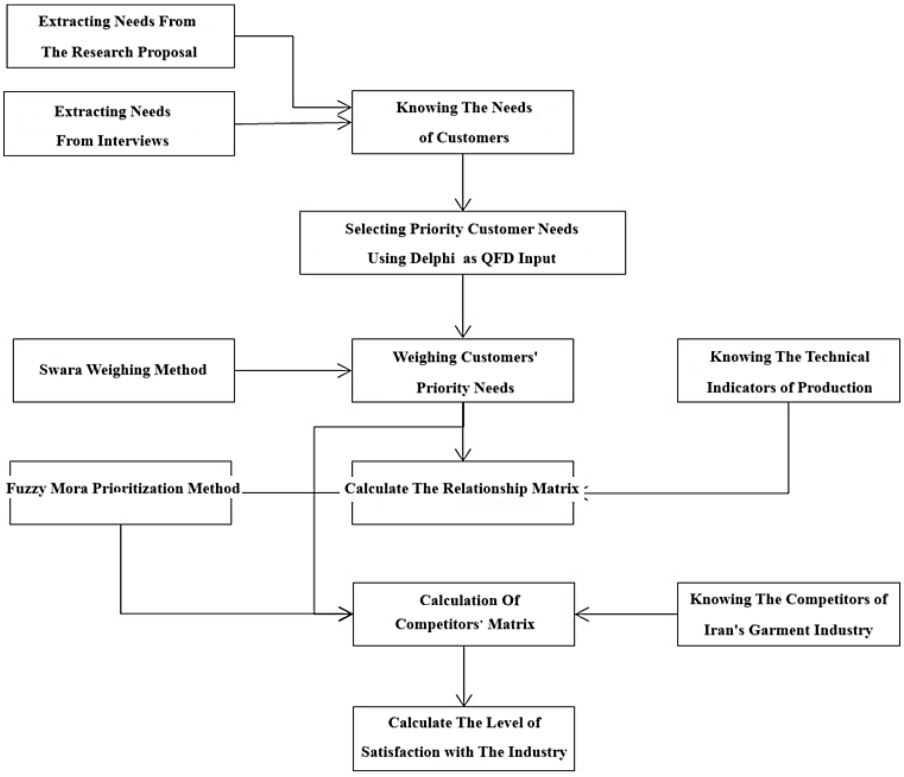

Fig. 1. Research process

3.3. Data Collection Methods

This research employs a combination of library research, expert interviews, and structured questionnaires. Customer needs and relevant indicators were initially identified through an extensive review of the literature and subsequently validated and supplemented through expert input. The Delphi method, along with Fuzzy SWARA and Fuzzy MORA techniques, were applied via questionnaires to systematically collect and analyze data.

3.4. Data Analysis Methods

The study integrates Delphi, Fuzzy SWARA, and Fuzzy MORA techniques in line with the research process.

3.5. Delphi Method

All factors identified through literature review and interviews are evaluated on a five-point scale. Only factors with scores exceeding four points advance to the subsequent stage. This prioritization enables the identification of performance-enhancing indicators while excluding those with minimal impact.

Table 2 presents the relative importance of factor jjj compared to the preceding factor j−1.

Table 2. Linguistic and Numerical Variables of Fuzzy SWARA [21]

Linguistic variables	Numerical scale
Equal importance	1, 1, 1
Relatively low importance	3/2, 1, 2/3
Little importance	2/3, 1/2, 2/5
Very little importance	2/5, 1/3, 2/7
Much less important	2/7, 1/4, 2/9

3.6. Fuzzy MORA Technique

Multi-criteria decision-making techniques can be classified into pairwise comparison, compromise, superiority, and scoring approaches. In this study, compromise techniques are not applicable as no negative criteria are considered. The primary objective is to assess the superiority of each technical indicator and determine its final score using the QFD framework. To achieve this, scoring techniques are preferred to evaluate the relationships between technical indicators and customer needs.

The Fuzzy MORA technique, as presented by Karande and Chakraborty (2012) [13], is used to analyze both the competition and relationship matrices. The procedure includes the following steps:

Dimensionless Decision Matrix: Constructed using the formula:

$$R_{ij} = \frac{(a_{ij}, b_{ij}, c_{ij})}{\sqrt{\sum (a_{ij}^2 + b_{ij}^2 + c_{ij}^2)}} \tag{1}$$

Conversion of Linguistic Variables: Linguistic indices are transformed into MORA fuzzy numbers as shown in Table 3.

Table 3. MORA Fuzzy Approximation

Linguistic variables	Fuzzy numbers
Very low	0.16, 0, 0
Low	0.34, 0.16, 0
Average down	0.5, 0.34, 0.16
Medium	0.66, 0.5, 0.34
Medium to high	0.84, 0.66, 0.5
High	1, 0.84, 0.66
Very high	1, 1, 0.84

Weighted Dimensionless Matrix: Each index weight obtained from Fuzzy SWARA is multiplied with its corresponding column to produce the weighted matrix:

$$T_{ij} = w_{ij} \cdot r_{ij} \tag{2}$$

Summation of Indicators: Given the positive nature of all indicators, the sum of each row is calculated as follows:

$$Y_i = \sum t_{ij} \tag{3}$$

Defuzzification: The surface center defuzzification method is applied:

$$DF_{ij} = \frac{(u_{ij} - l_{ij}) + (m_{ij} - l_{ij})}{3} + l_{ij} \tag{4}$$

3.7. Statistical Population

The experts participating in this study include experienced sellers, sales managers, and producers with expertise in clothing post-production and supply chain management. Out of 15 experts, six are from production departments, possessing sufficient knowledge to identify and evaluate technical indicators for each criterion. Table 4 presents their demographic characteristics.

Table 4. Demographic Characteristics of Experts

Indicator	Frequency (%)
Level of Education	
Undergraduate	40
Bachelor's degree	53.33
Master's degree	6.7
Expertise	
Wholesaler	33.33
Retail seller	26.67
Producer	40
Work experience	
5–10 years	20
10–20 years	26.67
20–30 years	33.33
Over 30 years	20
Average age	
20–30 years	20
30–40 years	20
40–50 years	33.33
50–60 years	26.67

3.8. Application of Combined Methods for Quality Measurement

The quality enhancement of the garment industry is based on the proposed methodology depicted in Figure 2. Traditional QFD assigns customer priority weights through simple weighting and determines the priority of technical requirements via a linear combination. In this study, QFD is improved through the integration of Fuzzy MORA, which enables more precise prioritization of technical requirements, competitor evaluation, and customer need weighting. The Delphi method was employed to select the priority needs of customers.

4. RESEARCH FINDINGS

The study examines the men's shirt segment in the clothing industry, focusing on formal and casual shirts. Customer needs were identified through structured interviews, as summarized in Table 2.

Table 2. Customer Needs Identification

Row	Indicator
1	Price
2	Product Quality
3	Fabric Type
4	Sewing Type
5	Aesthetic and Appearance
6	Design Based on Customer Request
7	Model
8	Fit
9	Packaging

The priorities of these needs differ between formal and casual shirts. Using a two-stage Delphi method, experts evaluated the importance of each indicator. Table 3 presents the average expert scores, and Figure 1 (omitted here) illustrates the Delphi results. Scores above 4 on a five-point Likert scale were considered for priority weighting using Fuzzy SWARA.

Table 3. Average Scores of Customer Needs (Delphi Method)

Customer Index	Formal Shirts	Casual Shirts
Price	3.78	4.00
Quality	4.44	4.00
Fabric Type	3.55	3.89
Sewing Type	4.00	4.55
Aesthetic & Appearance	4.00	4.55
Design Based on Customer Request	3.22	3.55
Model	3.33	4.22
Fit	4.22	4.33
Packaging	3.78	3.33

From the Delphi results, five core customer needs were identified for formal shirts: quality (C1), model (C2), fit (C3), sewing type (C4), and aesthetic/appearance (C5). For casual shirts, six core needs were prioritized: fit (C1), model (C2), aesthetic/appearance (C3), quality (C4), sewing type (C5), and price (C6).

Fuzzy SWARA calculations were performed to determine the relative weights of each indicator for both shirt types. Tables 4 and 5 summarize these calculations.

Table 4. Weights of Formal Shirt Indicators (Fuzzy SWARA)

Indicator	Average Score	Weight (K)	Final Score (q)
C1	-	1	0.459
C2	0.998	0.85	0.23
C3	0.82	0.758	0.126
C4	1.07	0.944	0.061
C5	1.017	0.94	0.03

Table 5. Weights of Casual Shirt Indicators (Fuzzy SWARA)

Indicator	Average Score	Weight (K)	Final Score (q)
C1	-	1	0.46
C2	0.98	0.889	0.233
C3	0.942	0.833	0.12
C4	1.055	1	0.058
C5	1.018	0.778	0.029
C6	0.734	0.722	0.003

To link customer needs to production technical indicators, a relationship matrix was constructed. The Fuzzy MORA technique was applied to determine the correlation between customer indicators (C1–C6) and production indicators (D1–D7), including sizing/patterning (D1), cutting (D2), gluing layers (D3), sewing (D4), adhesives for sleeves/wrists/collar (D5), buttons (D6), and packaging (D7). Tables 6 and 7 present the communication matrices for formal and casual shirts, respectively.

Table 6. Communication Matrix – Formal Shirts

	D1	D2	D3	D4	D5	D6	D7
C1	0.33	0.17	0.08	0.83	0.205	0.04	0
C2	0	0	0	0.92	0.25	0	0.705
C3	0.92	0.79	0.625	0.75	0.295	0.12	0
C4	0.75	0.58	0.42	0.705	0.04	0.03	0.04
C5	0.205	0.04	0	0.745	1	0.96	0.795

Table 7. Communication Matrix – Casual Shirts

	D1	D2	D3	D4	D5	D6	D7
C1	0.92	0.79	0.625	0.75	0.25	0.205	0.295
C2	0	0	0	0.92	0.25	0	0.705
C3	0.205	0.04	0	0.745	0.745	1	0.96
C4	0.33	0.17	0.08	0.83	0.34	0	0.42
C5	0.75	0.58	0.42	0.705	0.03	0.02	0.05
C6	0.205	0.04	0	0.165	0.01	0	0.745

The weighted scores of technical indicators were then calculated by multiplying the relationship matrix by the fuzzy SWARA scores, producing Tables 8 and 9, which provide the balanced matrix and final priority ranking.

Table 8. Balanced Matrix – Formal Shirts

	D1	D2	D3	D4	D5	D6	D7
Scores	0.16	0.41	0.29	0.5	0.03	0.01	0.21

Table 9. Balanced Matrix – Casual Shirts

	D1	D2	D3	D4	D5	D6	D7
Scores	0.46	0.38	0.29	0.84	0.03	0.02	0.38

The priority ranking of technical indicators for formal shirts is:

Sewing (D4) > Cutting (D2) > Packaging (D7) > Sizing & Patterning (D1) > Gluing layers (D3) > Adhesives (D5) > Buttons (D6)

For casual shirts:

Sewing (D4) > Cutting (D2) > Sizing & Patterning (D1) > Packaging (D7) > Gluing layers (D3) > Adhesives (D5) > Buttons (D6)

To assess market competition, initial and final scores were calculated for Iranian, Turkish, and Chinese shirts using the fuzzy MORA method (Table 10).

Table 10. Industry Satisfaction Scores (Competitors)

Country	Formal Shirts	Casual Shirts
Iran	0.84	0.82
Turkey	0.93	0.97
China	0.60	0.67

The results indicate that Turkish clothing leads in customer satisfaction in the Iranian market, followed by Iranian and Chinese brands.

5. CONCLUSION

This study proposed a QFD-based model integrated with Fuzzy SWARA and Fuzzy MORA to evaluate customer satisfaction in the men's shirt industry. The findings reveal:

1. Customer priorities differ between formal and casual shirts, with sewing quality emerging as the most critical technical indicator for both types.

2. The developed relationship matrix enables manufacturers to link customer needs to technical production indicators effectively.
3. Turkish clothing exhibits the highest customer satisfaction in Iran, demonstrating the utility of the industry satisfaction index in competitive benchmarking.

6. RESEARCH INNOVATIONS:

The study is among the first to integrate QFD, Fuzzy SWARA, and Fuzzy MORA in evaluating clothing industry indicators.

The industry satisfaction index provides a measurable framework for assessing market positioning and product improvement strategies.

7. PRACTICAL RECOMMENDATIONS:

Domestic manufacturers should implement continuous improvement programs focusing on sewing, cutting, and patterning to enhance customer satisfaction.

Industrial training should be provided to elevate technical capabilities, especially in sewing and finishing operations.

8. THEORETICAL RECOMMENDATIONS:

Although this study focused on men's shirts, the proposed model is applicable to women's and children's apparel. Future research may expand the industry satisfaction index to other product sectors for broader applicability.

Transparency Statement

The data supporting this study are available upon reasonable request to the corresponding author, subject to ethical and confidentiality considerations.

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Declaration of Interest

The authors declare that they have no competing interests.

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