Journal of System Management (JSM)
Online ISSN: 2538-1571, Print ISSN: 2322-2301
11(3), 2025, pp. 155-168

Received: 26/11/2024
Accepted: 07/02/2025

RESEARCH ARTICLE **Open Access**

Identifying and Ranking Obstacles to the Implementation of TQM in SMEs Using GMWM (Case study: Food Industry)

Mahnaz Zarei [1*], Mehdi Abbasi[2]

Abstract
This study identifies and ranks the obstacles to implement Total Quality Management (TQM) in small and medium-sized enterprises (SMEs) within the food industry. The aim is to determine the key barriers hindering TQM adoption and provide actionable insights to address these challenges. The research is applied and descriptive, using a survey-based methodology. Data were collected through structured questionnaires distributed to quality managers in food industry SMEs, selected via snowball sampling. The Group Best-Worst Method (GBWM) was employed to prioritize the identified barriers. Results reveal that "Lack of commitment and involvement of senior management" is the most significant obstacle, with an importance coefficient of 0.299, followed by "Senior management instability" and "High rate of employee turnover," each scoring 0.117. Also, consistency ratio values were close to zero, and the results were validated. This research contributes by offering practical recommendations for addressing TQM barriers and developing effective strategies tailored to SMEs in the food industry, especially in the context of developing countries.
Keywords: *Sized enterprises (SMEs), Food Industry, Group Best-Worst Method (GBWM)*

Introduction

Over the past three decades, organizations worldwide have witnessed the emergence and expansion of a diverse array of non-technological innovations designed to enhance management practices. In the face of increasing global competition, many organizations have been compelled to adopt appropriate technological strategies, skilled workforces, and managers equipped with the requisite expertise to navigate and coordinate these changes, with a sharp focus on quality and customer satisfaction (Aletaiby et al., 2021). TQM stands as a pivotal framework that underscores continuous improvement as a primary objective, thereby empowering organizations to attain commercial excellence. TQM encompasses a set of guiding principles and managerial practices aimed at fostering ongoing quality enhancement and ensuring the delivery of superior products to customers. To remain competitive in today's global market, organizations must effectively embed TQM principles throughout all their activities and operations (Muruganantham et al., 2018).

TQM serves as an efficient cost management system, driving quality improvement efforts across all levels of the organization, ensuring the provision of services and products that consistently satisfy customer expectations. The system seeks to cultivate a culture that improves the organization's ability to meet the evolving and diverse demands of customers. Moreover, successful TQM implementation can provide a formidable competitive edge. In the contemporary business environment, product quality has become one of the most significant tools for organizations to secure customer satisfaction, ultimately driving profitability. In general, organizations that

1*.Assistant Professor, Department of Industrial Engineering, Shiraz Branch, Islamic Azad University, Shiraz, Iran (Corresponding Author: delbina.zarei@gmail.com)
2. Associate Professor, Department of Industrial Engineering, Shiraz Branch, Islamic Azad University, Shiraz, Iran

successfully implement TQM enjoy numerous benefits. However, many organizations struggle with the effective execution of TQM, with research indicating that failure rates for implementation can reach as high as 41%. Two key factors often cited for these failures are the neglect of the crucial role of organizational culture in TQM implementation and a lack of understanding regarding the barriers that hinder its successful execution (Talapatra & Uddin, 2019).

The food industry, in particular, is currently experiencing a surge in global demand for food safety, higher product quality, and greater sustainability (Konstantinidis et al., 2023). Over recent years, food companies have seen significant growth on a global scale. In Iran, the food industry plays a critical role, particularly in ensuring food security and safeguarding public health, while also contributing substantially to the nation's exports. Among the various quality control methods employed in the food industry, the implementation of TQM has emerged as one of the most significant strategies. However, many companies face considerable challenges in the effective implementation and development of TQM. These barriers are not confined to any single domain; rather, they extend across all sectors of the organization, including production, services, and training. As such, it is crucial for organizations to identify these obstacles before and during the implementation process in order to mitigate their impact (Mohammadpour et al., 2024).

The problem of this study addresses is the difficulty in fully implementing TQM in SMEs within the food industry, particularly at Dadli Food Company. While TQM is recognized as an effective strategy for improving quality, customer satisfaction, and operational performance, many organizations, especially in the food sector, face substantial challenges in overcoming key barriers. Despite the company's efforts to implement TQM, these obstacles hinder the realization of its full potential, limiting improvements in product quality and customer satisfaction. Therefore, this research will focus on identifying and prioritizing these key obstacles to successful TQM implementation at Dadli Company, utilizing the Group Best-Worst Method (GBWM) to systematically analyze and rank these challenges.

Literature Review

Concept of Total Quality Management

Total Quality Management (TQM) is a continuous effort to meet and exceed customer expectations by improving the workforce and minimizing costs through a dedicated focus on organizational processes. TQM promotes a holistic approach to continuous improvement within an organization, addressing both internal and external customer needs while emphasizing the importance of timely actions. It is a structured method for planning and implementing processes to enhance product and service quality. TQM also involves rewards, resources, vision, philosophy, strategy, and organizational commitment (Akanmu et al., 2020). Overall, TQM is recognized as a major innovation in management, focusing on evaluating expectations, needs, and organizational cohesion through ongoing development at all organizational levels (Akanmu et al., 2023).

Food Industry

Food is a fundamental part of life, and the food industry is crucial for every nation. Quality and health-related issues are primary concerns. The industry covers a range of activities, including sourcing, production, processing, packaging, transportation, distribution, consumption, and disposal (Pereira et al., 2022). Food quality assurance is vital for compliance with standards. Neglecting quality can harm a company's survival and brand reputation. In the long run, investing in quality improves sales and export opportunities. The food industry uses internationally recognized quality assurance systems like HACCP, ISO, and BRC. However, studies show that TQM application in food distribution and supply is limited, despite its importance in improving competitiveness (Ghasemi & Kiandokht, 2018).

Obstacles in Implementing TQM

Identifying barriers to TQM implementation offers valuable insights for developing strategies to enhance the success of TQM and business performance (Kaur et al., 2021). Many studies have explored these obstacles, with Table 1 highlighting the most common factors that prevent TQM adoption.

Table 1.

Common Obstacles in implementing TQM

No.	Barriers	References
1	Lack of commitment and involvement of senior management	Mohammadpour et al. (2024), Yadav et al. (2022), Attri et al. (2021), Kaur et al. (2021), Aletaiby et al. (2021), Kumar et al. (2020)
2	Senior management instability	Mohammadpour et al. (2024), Attri et al. (2021), Talapatra and Uddin (2019)
3	Low employee engagement and lack of interest	Attri et al. (2021)
4	Employee resistance to change	Mohammadpour et al. (2024), Yadav et al. (2022), Kaur et al. (2021), Kumar et al. (2020), Talapatra and Uddin (2019)
5	Poor infrastructure facilities	Mohammadpour et al. (2024), Yadav et al. (2022), Attri et al. (2021)
6	Insufficient tools and equipment	Attri et al. (2021)
7	Lack of utilization of TQM tools, techniques, and methodologies	Mohammadpour et al. (2024), Yadav et al. (2022), Attri et al. (2021)
8	High rate of organizational turnover	Mohammadpour et al. (2024), Yadav et al. (2022)
9	Lack of training programs	Mohammadpour et al. (2024), Yadav et al. (2022), Kumar et al. (2020), Talapatra and Uddin (2019)
10	Insufficient knowledge or understanding of TQM philosophy	Attri et al. (2021)
11	Lack of budget for investment	Mohammadpour et al. (2024), Yadav et al. (2022), Talapatra and Uddin (2019)
12	Inadequate skills and experience among employees	Yadav et al. (2022)
13	Organizational rigidity towards environmental sustainability and technological changes	Attri et al. (2021)
14	Lack of long-term planning and policies	Mohammadpour et al. (2024), Attri et al. (2021), Kaur et al. (2021), Kumar et al. (2020), Talapatra and Uddin (2019)
15	Lack of clarity in organizational policies regarding TQM programs	Mohammadpour et al. (2024), Yadav et al. (2022), Attri et al. (2021), Kaur et al. (2021)

Application of TQM in various industry

Fili et al. (2019) identified the key success factors of TQM and ranked them by using a combined approach based on fuzzy Decision making trial and evaluation laboratory (DEMATEL) and Fuzzy Analytic Network Process (FANP). The results indicated that the most influential factors for TQM success were senior management commitment and leadership, human resource management, and, finally, education and learning. On the other hand, supplier management and benchmarking had the least impact. Talapatra and Uddin (2019) examined the relative importance of various barriers to TQM in the apparel industry in Bangladesh, using the FAHP. The results of their study show that inappropriate planning for TQM implementation, lack of financial support, lack of employee training, lack of employee empowerment, and inadequate physical resources are among the most significant barriers to the successful implementation of TQM.

Sarbandi and gholizadeh (2020) examined the relationship between TQM, customer satisfaction, and customer loyalty, considering the mediating role of service quality in bank branches. They used structural equation modeling for data analysis. The results of their study showed a significant relationship between the application of TQM and both customer satisfaction and loyalty, with service quality acting as a mediator. Kumar et al. (2020) conducted a study to identify the key human and operational barriers to implementing sustainable TQM in Indian organizations using a fuzzy Interpretive Structural Modeling (ISM) approach. Their findings revealed that relational barriers, including a lack of teamwork, absence of performance measurement and evaluation criteria, untimely implementation of programs, and inadequate planning, play a significant role in hindering sustainable TQM.

Kaur et al. (2021) aimed to identify the main barriers to the synergy of TQM and Supply Chain Management (SCM) in medium and large manufacturing companies in India using the Vise Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR) method. The results suggest that the synergy between TQM and SCM is still in its early stages in India. Attri et al. (2021) prioritized barriers to the successful implementation of TQM in Indian manufacturing companies using the Best-Worst Method (BWM). The ranking results show that the most significant deterrents to TQM implementation include lack of senior management commitment and involvement, absence of continuous training, and lack of employee engagement and indifference. The goal of the research by Dehghani et al. (2022) was to explore the barriers to implementing TQM in hospitals in Kerman city using statistical analysis. Their findings indicated that there is a significant relationship between cultural and workforce barriers, infrastructure-related barriers, and managerial barriers with the successful implementation of TQM, with a confidence level of more than 99%.

Yadav et al. (2022) analyzed the causal relationships between human-related and system-related barriers to TQM in the automotive industry using the fuzzy DEMATEL method. Their findings indicate that key obstacles include lack of senior management commitment, budget shortages, lack of advanced production facilities, and employee resistance to change. Hchaichi (2023) analyzed the critical success factors of TQM in public sector companies using multiple linear regression. The results confirm that the successful implementation of TQM requires a culture of trust, loyalty, good communication, and social cohesion. Akanmu et al. (2023) explored the relationship between TQM practices and sustainability aspects in Malaysian food and beverage manufacturing companies using Structural Equation Modeling (SEM). Their findings emphasize that effective continuous process improvement, benchmarking, quality assurance, service design, and information analysis have a significant positive impact on sustainability.

Sfakianaki et al. (2023) conducted an empirical study to examine the current status of TQM implementation in elementary education centers in Greece. They tested 37 components in seven major dimensions and found a positive impact between TQM and elementary education centers. Nguyen et al. (2023) applied Delphi and AHP techniques to identify the key factors and indicators for implementing a 4.0 industrial generation-based TQM model in manufacturing companies. Their findings showed that social factors were more significant than technical factors. Mohammadpour et al. (2024) investigated barriers to implementing TQM in the Solico Food and Beverage Production Group. The GBWM was used to prioritize these barriers. The results revealed that the most significant barriers were the lack of top management commitment and participation, high organizational burnout rate, and instability due to frequent changes in senior management.

Research gap and novelty

Despite the extensive body of literature on TQM implementation across various industries, several critical gaps remain. Studies, such as those by Talapatra and Uddin (2019), Kumar et al. (2020), and Attri et al. (2021), have identified key barriers to TQM implementation in service and manufacturing sectors. However, the majority of these investigations have focused on industries like apparel, automotive, and general manufacturing, leaving significant areas, such as the food industry, underexplored. The main novelty of this research lies in its focus on the food industry—a sector that remains largely underrepresented in TQM research, despite its unique challenges and requirements.

In addition, while methodologies such as AHP have been widely used to prioritize and analyze barriers, few studies have adopted novel decision-making methods like the BWM. BWM offers a distinct advantage over AHP. The method's primary strengths are its reduced number of pairwise comparisons. Also, by utilizing a non-linear model, BWM allows for the calculation of an optimal range of weights (Rezaei, 2015, Rezaei, 2016). In addition, the solution of the BWM can be obtained by solving the mixed integer linear programming model (Dehghani & Abbasi, 2022a), and the weights of the BWM criteria can be determined and estimated by solving linear programming or mixed integer linear programming models (Abbasi & Dehghani, 2025). Using other forms of BWM like the Trustable BWM Algorithm can be beneficial, too (Dehghani & Abbasi, 2022b). In the case of TQM barriers, the factors are often qualitative, which requires a method that can evaluate them effectively. As decision-making becomes more complex in advanced environments, making optimal decisions while considering all aspects of the issue becomes increasingly difficult. Therefore, it is essential to rely on the opinions of an expert committee. The experts can be selected using snowball sampling. Considering what has been stated, further novelty of this study is the application of the GBWM to identify and prioritize barriers to TQM implementation in the food industry, a sector that has been underexplored in the existing literature.

Research Methodology

The present study is applied in terms of its purpose and utilizes a survey research method for data collection. Data were collected using structured questionnaires, which were carefully designed based on a comprehensive review of the relevant literature. The GBWM was applied to analyze and rank the identified barriers. The target population comprises quality control and assurance managers from small and medium-sized enterprises (SMEs) within the food industry, with Dadli Food Company serving as the case study. Participants were selected using the snowball sampling method, which facilitated access to knowledgeable individuals actively engaged in quality management processes at Dadli Food Company. The data collection process commenced with a semi-structured interview with the company's CEO. Pre-prepared questions were provided to the interviewee in advance. At the conclusion of the interview, the CEO was asked to recommend additional suitable participants for the study. Subsequently, interviews were conducted with other experts. The expert committee was finalized as outlined in Table 2.

Table 2.
Expert Panel Information at Dadli Food Company

Row	Organizational Position	Experience (Years)	Code
1	CEO	18	E1
2	Compliance Manager (Quality Control)	12	E2
3	Senior Quality Assurance Manager	15	E3
4	Senior Audit and Standardization Expert	10	E4
5	Production Planning Expert	8	E5

The research began with an interview with the company's CEO. The interview was semi-structured, with pre-prepared questions provided to the interviewee beforehand. At the end of the interview, the CEO was asked to recommend additional suitable participants for the study. Similarly, interviews were conducted with other experts. Data collection utilized Delphi questionnaires and the GBWM.The proposed research process included the following stages:

1. Forming an expert team to collect data using the snowball sampling method.
2. Validating TQM implementation barriers identified from the literature review (Table 1) using the Delphi method.
3. Determining the importance coefficients of barriers by the GBWM (includes 3 steps).

Delphi Method

The process of finalizing the barriers to implementing TQM in the food industry, with a focus on Dadli Company, involved distributing questionnaires to the members of the expert panel. Each member was asked to evaluate the identified barriers to TQM implementation based on a binary scale of "agree" or "disagree." At the end of the questionnaire, respondents were also requested to suggest any additional barriers they deemed relevant. Barriers that received unanimous agreement from all experts were selected for inclusion. If no additional barriers were suggested by the experts, the screening and validation process concluded at this stage. However, if new barriers were proposed, the validation process proceeded to the next round. This iterative process continued until no new barriers were suggested in a given round, ensuring a comprehensive and consensus-driven final list of barriers.

The steps of GBWM

The steps of the GBWM are described as follows (Safarzadeh et al., 2018):

Step 1: Determining Initial Information

In this step, the required input information related to each decision-maker is collected. This includes the set of decision criteria, weighting coefficients of experts which reflect their subjective preferences based on their experience; best and worst criteria selected by the experts; Pairwise comparison vectors between the best and worst criteria and the other criteria.

It is important to note that best and worst criteria are considered equally significant for the group decision-making problem. To ensure that the best and worst criteria are consistent across all experts, the method of using expert weight coefficients is applied. In this study, linear normalization is used to calculate expert weight coefficients. In this method, each value in a set is divided by the total sum of the elements in that set. After normalization, the total sum of the elements will equal one. The index used to determine the expert weight coefficients is the work experience and expertise of the experts. This method is illustrated in Equation 1.

$$n_{ij} = r_{ij} / \sum_{i=1}^{m} r_{ij} \quad (1)$$

To explain how to achieve a consistent selection of the best and worst criteria for all experts using expert weight coefficients, a case example is provided as follows. For example, if a group decision-making problem involves three experts and four criteria (E, F, G, and H), the experts' opinions are aggregated as shown in Table 3, and the final best and worst criteria are determined accordingly:

Table 3.
Selection of best and worst criteria

Expert	Expert's weight	Initial best and worst criteria	Score	Final best and worst criteria
E_1	0.3	$(B:F,W:G)$	$B=\{E=0.2;\ F=0.3+0.5\}$	$(B:F,W:H)$
E_2	0.2	$(B:E,W:H)$		
E_3	0.5	$(B:F,W:H)$	$W=\{G=0.3;\ H=0.2+0.5\}$	

Step 2: Calculating the criteria weights through solving the nonlinear programming model

The objective of this model is to minimize the total consistency deviations for all experts. Accordingly, the minimization model is formulated as follows in Equation 2:

$$\min \sum_{k\in D} w'_k Max_i \left\{\left|\frac{w_B}{w_i} - a^k_{Bi}\right|, \left|\frac{w_i}{w_W} - a^k_{iW}\right|\right\}$$
$$S.t.$$
$$\sum_i w_i = 1 \qquad (2)$$
$$w_i \geq 0;\ \forall i \in C$$

In the objective function of this model, w'_k represents the weight coefficient of the experts, which is adjusted as percentage values from [0,100]. By solving the above mathematical model, the optimal weights of the criteria $(W^*_1, W^*_2, \dots, W^*_n)$ are calculated. To simplify model 2, the term ξ_k is defined as in Equation 3:

$$\xi_k = Max_i \left\{\left|\frac{w_B}{w_i} - a^k_{Bi}\right|, \left|\frac{w_i}{w_W} - a^k_{iW}\right|\right\} \quad \forall k \in D \qquad (3)$$

Therefore, the proposed model 3 is transformed into the final model 4:

$$\min \sum_{k\in D} w'_k \xi_k$$
$$S.t.$$
$$\left|\frac{w_B}{w_i} - a^k_{Bi}\right| \leq \xi_k \quad \forall i \in C; \forall k \in D \qquad (4)$$
$$\left|\frac{w_i}{w_W} - a^k_{iW}\right| \leq \xi_k \quad \forall i \in C; \forall k \in D$$
$$\sum_i w_i = 1$$
$$w_i \geq 0;\ \forall i \in C$$

Step 3: Obtaining consistency ratio of the problem to evaluate the results

In the next step of the GBWM, a consistency ratio is calculated to verify the reliability of the comparisons. After solving the mathematical model, the optimal values of ξ^*_k are used to compute the consistency ratio for each expert (CR_k) and for the overall group decision-making consistency ratio (CR^G). Generally, Equation 5 is used to represent the consistency ratio for the k-th expert, and Equation 8 is used to determine the group consistency ratio:

$$CR_k = w'_k\left(\frac{\xi^*_k}{CI^\theta}\right) \quad \forall k \in D \qquad (5)$$
$$CR^G = Max_k\{CR_k\} \qquad (6)$$

In this context, θ represents a non-negative value that indicates the sensitivity of the model. According to the research by Safarzadeh et al. (2018), this value is assumed to be 1 by default. Similar to the original version of the BWM, the consistency index values for a group decision-making problem are reported in Table 5. In this table, the maximum preferences of the experts are given by $a^{max}_{BW} = Max_k a^k_{BW}$.

Table 4.
Consistency index

a^{max}_{BW}	1	2	3	4	5	6	7	8	9
CI	0.00	0.44	1.00	1.63	2.30	3.00	3.73	4.47	5.23

Therefore, the closer the consistency ratio (CR) is to zero, the higher the consistency of the comparisons made. In fact, a lower CR indicates that the opinions and preferences of the experts are more aligned and consistent with each other, which in turn increases the reliability and credibility of the group decision-making process.

Findings of the Study

Determining the Expert Weights

Considering that the issue under study in this research is a group decision-making problem and one of the input parameters for the proposed nonlinear programming model of the GBWM is the weight of the preferences and subjective judgments of each expert committee member, in this step, the expert weight for each member of the committee was determined using the linear normalization method (Equation 1). The weight for each committee member relative to the experience index is shown in Figure 1. The process works by dividing each committee member's years of experience by the total years of experience of all members.

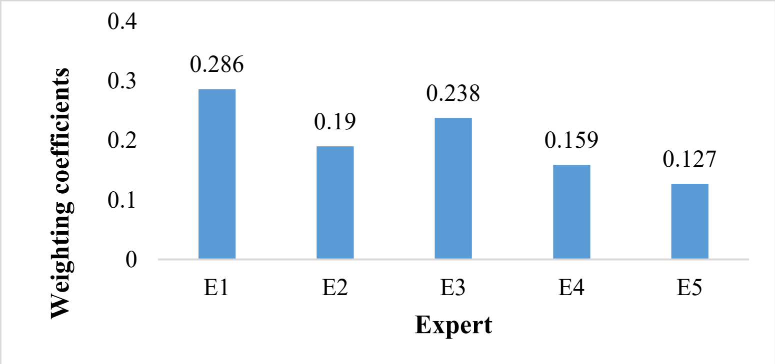

Figure 1. *Weighting coefficients of the expert committee*

According to the results obtained, the expert weights for CEO of the company, Senior Quality Assurance Manager, Compliance Manager (Quality Control), Senior Audit and Standardization Expert, and Production Planning Expert were found to be 0.286, 0.190, 0.238, 0.159, and 0.127, respectively.

Determining the Final Barriers

According to the literature review, an initial list of 15 barriers was identified and extracted, as shown in Table 1. A Delphi method questionnaire was then designed and distributed to the expert committee members, asking them to indicate their agreement or disagreement with each of the identified barriers. At the end, experts were also given the opportunity to suggest any additional barriers not included in the initial list. Afterward, all questionnaires were collected. The data collected from the questionnaires were then analyzed using the Delphi method. In general, after conducting the Delphi method over three rounds, the final list of barriers was determined, as shown in Table 5.

Table 5.
Finalized obstacles identified by Delphi method

Code	Description
B1	Lack of commitment and involvement of senior management
B2	Senior management instability
B3	Employee resistance to change
B4	Lack of utilization of TQM tools, techniques, and methodologies
B5	High rate of employee turnover
B6	Insufficient knowledge or understanding of TQM philosophy
B7	Lack of budget for investment
B8	Inadequate skills and experience among employees
B9	Organizational rigidity towards environmental sustainability and technological changes

Determining the Priority of Barriers

In this step, the most significant (best) and least significant (worst) barriers affecting the implementation of TQM were identified based on the opinions of the expert committee. The results are shown in Table 6.

Table 6.
Best and worst barriers identified by each expert

Barriers	Experts	
	Best	Worst
B1	E1, E3	
B2	E2, E5	
B3		
B4		E1
B5		
B6		E2
B7	E4	
B8		E3, E5
B9		E4

Subsequently, utilizing the expert weighting method, the opinions of experts regarding the identification of the most significant (best) and least significant (worst) barriers were aggregated, as presented in Table 7.

Table 7.
Final best and worst barriers based on expert opinions

Expert	w'_k	Best and worst criteria selected by experts	Final Score
E_1	0.286	$(B: B_1, W: B_4)$	$B = \begin{cases} B_1 = 0.524 \\ B_2 = 0.317 \\ B_7 = 0.159 \end{cases}$
E_2	0.190	$(B: B_2, W: B_6)$	
E_3	0.238	$(B: B_1, W: B_8)$	$W = \begin{cases} B_6 = 0.286 \\ B_6 = 0.190 \\ B_8 = 0.365 \\ B_{10} = 0.159 \end{cases}$
E_4	0.159	$(B: B_7, W: B_9)$	
E_5	0.127	$(B: B_2, W: B_8)$	

As shown in Table 7, the barrier of "Lack of commitment and involvement of senior management" (B1) was selected as the most important (best criterion) by expert E1 with a weight of 0.286 and expert E3 with a weight of 0.238. Therefore, the final weighted score for this barrier is 0.524. Additionally, the barrier of "Inadequate skills and experience among employees" (B8) was selected as the least important (worst criterion) by expert E3 with a weight of 0.238 and expert E5 with a weight of 0.127. Consequently, the final weighted score for this barrier is 0.365. Therefore, among the barriers, B1 is the most important, and B8 is the least important. In the next step, the priority of the best criterion relative to other criteria, as well as the priority of other criteria relative to the worst criterion, was determined by the experts based on a scoring range of {1, 2, ..., 9}. Finally, the pairwise comparison vectors of the best criterion with other criteria (Best-to-others), and other criteria with the worst criterion (Others-to-worst), for each expert are shown in Tables 8 and 9.

Table 8.
Best-to-others (BO) vectors

Expert	Best	Best-to-others vectors								
		B1	B2	B3	B4	B5	B6	B7	B8	B9
E1	B1	1	2	3	3	2	3	5	9	2
E2	B1	1	3	5	5	2	2	3	8	3
E3	B1	1	2	2	4	4	3	3	9	5
E4	B1	1	3	3	4	3	3	5	8	3

E5	B1	1	5	5	3	2	5	4	9	2

Table 9.
Others-to-worst (OW) vectors

Expert	Worst	Others-to-worst vectors								
		B1	B2	B3	B4	B5	B6	B7	B8	B9
E1	B8	9	5	3	3	5	3	2	1	4
E2	B8	8	2	3	3	5	2	3	1	3
E3	B8	9	3	5	4	3	4	2	1	4
E4	B8	8	2	3	2	5	2	3	1	3
E5	B8	9	4	5	3	3	2	2	1	2

After determining the priority of the barriers, a nonlinear programming model was developed to calculate the weights of the barriers according to Equation 4. The model was solved using GAMS software version 24.3 with the Baron solver. Based on the results, the barriers of "Lack of commitment and involvement of senior management" (B1), "Senior management instability" (B2), and "High rate of organizational turnover" (B5) were ranked first to third, with final weights of 0.299, 0.117, and 0.117, respectively, and were identified as the most significant barriers. The global weight and also priority of the barriers to the implementation of TQM at Dadli Food Company is presented in Table 10.

Table 10.
Final Prioritization of Barriers in TQM Implementation

No.	**Barriers**	**Global weight**	**Rank**
1	Lack of commitment and involvement of senior management (B1)	0.299	1
2	Senior management instability (B2)	0.117	2
3	Employee resistance to change (B3)	0.095	4
4	Lack of utilization of TQM tools, techniques, and methodologies (B4)	0.083	7
5	High rate of employee turnover (B5)	0.117	3
6	Insufficient knowledge or understanding of TQM philosophy (B6)	0.086	6
7	Lack of budget for investment (B7)	0.077	8
8	Inadequate skills and experience among employees (B8)	0.03	9
9	Organizational rigidity towards environmental sustainability and technological changes (B9)	0.095	5

After solving the model, the ξ^* values associated with each expert are reported in Table 11. Considering θ=1, the consistency ratio (CR^G) for the group decision-making problem, calculated using relations 5 and 6, is the maximum value from the set {0.062, 0.079, 0.084, 0.066, 0.059}, which is 0.084. Since the consistency ratio is close to zero, the obtained results have acceptable validity.

Table 11.
Consistency ratio for the obtained weights

Expert	w'_k	ξ^*	a_{BW}^{max}	CI	CR_k
E_1	0.286	1.140	9	5.23	0.062
E1	0.190	1.860	8	4.47	0.079
E2	0.238	1.860	9	5.23	0.084
E3	0.159	1.860	8	4.47	0.066
E4	0.127	2.446	9	5.23	0.059

To clarify how the consistency ratios are obtained, the calculations for expert E1 are explained. Since the priority degree of the best criterion over the worst criterion (a_{BW}^{max}) is 9, according to Table 5, the consistency index (CI) for the pairwise comparisons is 5.23. Therefore, the consistency ratio for expert E1, using the equation 5 ($CR_k = w_k'\left(\frac{\xi_k^*}{CI^\theta}\right) = 0.286 \times \frac{1.140}{5.23} = 0.062$), is calculated as 0.062. This indicates a very high consistency of the results for expert E1, as this value is close to zero. Similarly, the consistency ratios for other experts are reported in Table 11.

Discussion and Conclusion

The food industry today faces a myriad of challenges. To remain competitive, the sector must adopt advanced technologies and innovative approaches, as failing to do so risks falling behind. In the 19th century, the number of producers in the market was limited, and products were constrained in terms of volume, variety, and innovation. In contrast, today's market is highly competitive, demanding that food industries focus on various aspects such as cost efficiency, production speed, and timely delivery to customers.

The primary objective of this study was to identify and prioritize the barriers to implementing TQM in the food industry, specifically at Dadli Food Company, using GBWM. The initial stage involved reviewing existing research and focusing on highly cited articles to compile an initial list of barriers to TQM implementation, as detailed in Table 1. These barriers were then analyzed using the Delphi method in the second stage. Ultimately, nine significant barriers were identified as obstacles to implementing TQM at Dadli Food Company: lack of commitment and involvement of senior management, senior management instability, employee resistance to change, lack of utilization of TQM tools, techniques, and methodologies, high rate of employee turnover, insufficient knowledge or understanding of TQM philosophy, lack of budget for investment, inadequate skills and experience among employees, Organizational rigidity towards environmental sustainability and technological changes. Subsequently, these barriers were prioritized using GBWM in the third stage (includes 3 steps). The results, shown in Table 10, revealed that "Lack of commitment and involvement of senior management" ranked as the most significant barrier with an importance coefficient of 0.299, followed by "Senior management instability" (0.117) and "High rate of employee turnover" (0.117). Furthermore, the consistency ratio of the results, found in Table 11, was close to zero, demonstrating the high reliability of the weights assigned to the barriers.

Based on the findings of the study, the following key recommendations are made to overcome the barriers to TQM implementation at food industries, particularly at Dadli Food Company. These recommendations are framed in the context of existing research and provide managerial insights for overcoming the identified challenges:

This study identified of commitment and involvement of senior management as the most significant barrier to TQM implementation. This finding is consistent with several prior studies. Fili et al. (2019) and Attri et al. (2021) emphasize that senior management involvement is crucial for successful TQM adoption. Similarly, Kumar et al. (2020) and Mohammadpour et al. (2024) highlight that inadequate management commitment results in insufficient resource allocation and poor implementation of TQM strategies. To address this issue, it is essential for senior management to not only endorse but actively engage in the TQM process. This can be achieved by providing the necessary resources, such as advanced tools, machinery, and training programs. Moreover, it is important for senior management to lead by example, demonstrating their commitment to quality and fostering a culture of ownership among employees. Ensuring that senior management plays an active, visible role in TQM will motivate employees and facilitate a more effective and sustainable quality management system.

The issue of senior management instability was another significant barrier highlighted in this study. This aligns with the findings of Mohammadpour et al. (2024), who also identify leadership instability as a challenge for TQM implementation. Instability in leadership creates inconsistency in decision-making, disrupts long-term strategic planning, and negatively impacts organizational performance. Research consistently shows that stable leadership is vital for the successful execution of quality improvement initiatives. To mitigate the impact of leadership instability, it is recommended that food companies consider extending the tenure of senior management positions and ensure smooth transitions in leadership. This stability allows for better continuity in implementing TQM strategies and ensures that long-term goals are maintained. Additionally, structured succession planning can help preserve institutional knowledge and maintain organizational consistency. A stable leadership team will be crucial in fostering a culture of quality and supporting continuous improvement.

High rate of employee turnover was identified as another barrier to TQM success in this study. This finding is corroborated by Mohammadpour et al. (2024), who also point out that high turnover negatively affects organizational cohesion and hinders TQM adoption. High turnover disrupts team dynamics and results in the loss of critical knowledge, which impedes the smooth execution of quality initiatives. To address this challenge, food companies should focus on aligning compensation, benefits, and incentives with employee skills, experience, and job responsibilities. Offering competitive, performance-based rewards will help attract and retain talent. Furthermore, fostering a positive work culture, providing opportunities for career growth, and implementing clear paths for advancement can reduce turnover and improve employee engagement. By creating a stable and motivated workforce, the company can improve operational efficiency, retain valuable knowledge, and foster a long-term commitment to TQM.

In conclusion, the study reveals that the success of TQM implementation at Dadli Food Company, and by extension, in the broader food industry, depends heavily on overcoming key barriers such as lack of senior management commitment, leadership instability, and high employee turnover. By focusing on management involvement, leadership stability, and employee retention, food companies can significantly improve their ability to implement TQM and enhance overall operational efficiency. The recommendations provided offer practical solutions that can help food companies, particularly SMEs like Dadli Food Company, to not only address these barriers but also build a sustainable competitive advantage in today's fast-evolving food market.

Conflict of Interest

The corresponding author declares that there is no conflict of interest regarding the authorship or publication of this article.

References

Abbasi, M., & Dehghani, M. R. (Accepted). Determining and Estimating the Weights of Best-Worst Method Criteria through Solving Linear Programming or Mixed Integer Linear Programming Models. *Journal of New Researches in Mathematics*.

Akanmu, M. D., Hassan, M. G., & Bahaudin, A. Y. B. (2020). A preliminary analysis modeling of the relationship between quality management practices and sustainable performance. *Quality Management Journal*, *27*(1), 37-61. https://doi.org/10.1080/10686967.2019.1689800.

Akanmu, M. D., Hassan, M. G., Mohamad, B., & Nordin, N. (2023). Sustainability through TQM practices in the food and beverages industry. *International Journal of Quality & Reliability Management*, *40*(2), 335-364. https://doi.org/10.1108/IJQRM-05-2021-0143.

Aletaiby, A. A., Rathnasinghe, A. P., & Kulatunga, P. (2021). Influence of top management commitment towards the effective implementation of TQM in Iraqi oil companies. *Journal of Petroleum Exploration and Production*, *11*, 2039-2053. https://doi.org/https://doi.org/10.1007/s13202-021-01131-3.

Attri, R., Khan, N. Z., Siddiquee, A. N., & Khan, Z. A. (2021). Analysing the barriers to successful implementation of total quality management in Indian manufacturing organisations using best-worst method. *International Journal of Business Excellence*, *24*(2), 275-294. https://doi.org/https://doi.org/10.1504/IJBEX.2021.115747.

Dehghani, A., Salajegheh, S., Mohammad Bagheri, M., & Mehdizadeh, S. (2022). Investigating Barriers and Providing an Appropriate Model for Establishing Total Quality Management: A Case Study in Hospitals. *hums-jmis*, *7*(4), 44-51. https://doi.org/10.52547/jmis.7.4.44.

Dehghani, M. R., & Abbasi, M. (2022a). Estimating the Solution of the Best-Worst Method Non-Linear Programming Model by solving the Mixed Integer Linear Programming Model Solutions. *Journal of New Researches in Mathematics*, 8(37), 41-70. https://sanad.iau.ir/Journal/jnrm/Article/798081

Dehghani, M. R., & Abbasi, M. (2022b). Performance Evaluation of Thermal Power Generation Companies using Integrated Proposed Trustable BWM Algorithm and BSC Model. *Iranian Electric Industry Journal of Quality and Productivity*, 10(4), 64-72. http://ieijqp.ir/article-1-811-fa.html

Fili, A., Pouya, A. R., Kazemi, M., & Fakoor Saqieh, A. (2019). Identification and Ranking of Key Success Factors of Total Quality Management with Fuzzy Dimtel Approach and Analysis of Fuzzy Networks (Case Study: Akhshan Manufacturing Company) *Journal of Quality Engineering and Management*, *9*(1), 80-100. https://doi.org/https://dor.isc.ac/dor/20.1001.1.23221305.1398.9.1.6.5.

Ghasemi, A. R., & Kiandokht, B. (2018). Proposing an Integrated Approach for Total Quality Management Using Soft System Methodology – The Case of a Food Industrial Company. *Journal of Quality Engineering and Management*, *8*(2), 116-132. https://doi.org/https://dor.isc.ac/dor/20.1001.1.23221305.1397.8.2.4.8.

Hchaichi, R. (2023). The Key Success Factors of Total Quality Management Implementation in State-Owned Enterprise. *International Journal of Public Administration*, *46*(2), 156-167. https://doi.org/10.1080/01900692.2021.1993902.

Kaur, M., Singh, K., & Singh, D. (2021). Identification of barriers to synergistic implementation of TQM-SCM. *International Journal of Quality & Reliability Management*, *38*(1), 363-388. https://doi.org/https://doi.org/10.1108/IJQRM-05-2019-0141.

Konstantinidis, F. K., Balaska, V., Symeonidis, S., Tsilis, D., Mouroutsos, S. G., Bampis, L., . . . Gasteratos, A. (2023). Automating dairy production lines with the yoghurt cups recognition and detection process in the Industry 4.0 era. *Procedia Computer Science*, *217*, 918-927. https://doi.org/https://doi.org/10.1016/j.procs.2022.12.289.

Kumar, V., Verma, P., Mangla, S. K., Mishra, A., Chowdhary, D., Sung, C. H., & Lai, K. K. (2020). Barriers to total quality management for sustainability in Indian organizations. *International Journal of Quality & Reliability Management*, *37*(6/7), 1007-1031. https://doi.org/https://doi.org/10.1108/IJQRM-10-2019-0312.

Mohammadpour, M., Afrasiabi, A., & Yazdani, M. (2024). Identifying and prioritizing the barriers to TQM implementation in food industries using group best-worst method (a real-world case study). *International Journal of Productivity and Performance Management*,73(10), 3335-3362. https://doi.org/10.1108/IJPPM-11-2023-0602.

Muruganantham, G., Vinodh, S., Arun, C. S., & Ramesh, K. (2018). Application of interpretive structural modelling for analysing barriers to total quality management practices implementation in the automotive sector. *Total Quality Management & Business Excellence*, *29*(5-6), 524-545. https://doi.org/10.1080/14783363.2016.1213627.

Nguyen, T. A. V., Tucek, D., & Pham, N. T. (2023). Indicators for TQM 4.0 model: Delphi Method and Analytic Hierarchy Process (AHP) analysis. *Total Quality Management & Business Excellence*, *34*(1-2), 220-234.

https://doi.org/10.1080/14783363.2022.2039062.

Pereira, L., Couto, M., Costa, R. L. D., Dias, Á., Gonçalves, R., & Silva, R. V. D. (2022). Food and beverage industry in a pandemic context. *International Journal of Services, Economics and Management*, *13*(2), 152-181. https://doi.org/https://doi.org/10.1504/IJSEM.2022.122738.

Rezaei, J. (2015). Best-worst multi-criteria decision-making method. *Omega*, *53*, 49-57. https://doi.org/10.1016/j.omega.2014.11.009

Rezaei, J. (2016). Best-worst multi-criteria decision-making method: Some properties and a linear model. *Omega*, *64*, 126-130. https://doi.org/10.1016/j.omega.2015.12.001

Safarzadeh, S., Khansefid, S., & Rasti-Barzoki, M. (2018). A group multi-criteria decision-making based on best-worst method. *Computers & Industrial Engineering*, *126*, 111-121. https://doi.org/https://doi.org/10.1016/j.cie.2018.09.011.

sarbandi, s., & gholizadeh, h. (2020). An Investigation on the Relationship between Comprehensive Quality Management Application on Customer Satisfaction and Customer Loyalty. *Commercial Surveys*, *18*(103), 101-116. https://doi.org/https://dor.isc.ac/dor/20.1001.1.26767562.1399.18.103.6.5.

Sfakianaki, E., Kaiseroglou, N., & Kakouris, A. (2023). An instrument for studying TQM implementation in primary education: development and empirical investigation. *Quality Assurance in Education*, *31*(3), 452-468. https://doi.org/10.1108/QAE-10-2022-0189.

Talapatra, S., & Uddin, M. K. (2019). Prioritizing the barriers of TQM implementation from the perspective of garment sector in developing countries. *Benchmarking: An International Journal*, *26*(7), 2205-2224. https://doi.org/https://doi.org/10.1108/BIJ-01-2019-0023.

Yadav, R. N., Kumar, D., Sharma, A. K., & Virmani, N. (2022). Analysing human and system related barriers of TQM in automobile industries using fuzzy DEMATEL approach. *International Journal of Productivity and Quality Management*, *35*(2), 193-219. https://doi.org/https://doi.org/10.1504/IJPQM.2022.121302.