An Empirical Assessment of the Synergistic Effects of Total Quality Management and Food Safety Management on Firm Performance Using Structural Equation Modeling

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ABSTRACT

The food industry plays a crucial role in Thailand's economic growth, establishing the nation as a prominent global center for food production and export. To remain competitive in an increasingly demanding international market, organizations within the food sector must implement comprehensive quality and safety management systems. Total Quality Management (TQM) enhances operational efficiency and product quality, while Food Safety Management (FSM) ensures compliance with regulatory standards and addresses consumer expectations regarding food safety. This study examines the interrelationship between TQM and FSM practices and their combined influence on organizational performance. Structural Equation Modeling (SEM) was applied to assess both the direct and indirect effects among the proposed constructs, and the results indicated that TQM and FSM exert significant positive effects on organizational performance, with TQM directly influencing the implementation of FSM. Furthermore, it was found that FSM influences the relationship between TQM and organizational performance. The findings contribute to the theoretical understanding of integrated management systems and provide practical insights for improving organizational performance through the effective alignment of quality and FSM practices.

Keywords-Total Quality Management; Food Safety Management; Organizational Performance; Structural Equation Modeling; Thai Food Industry

I. INTRODUCTION

The global food industry is under growing pressure to ensure both product quality and safety while sustaining competitive performance. Thailand is a major hub for food production and export in Southeast Asia, so this challenge has become increasingly significant due to heightened consumer expectations, stringent international regulations, and the expanding complexity of food supply chains. In response, many organizations have adopted strategic management systems, such as TQM and FSM to improve operational efficiency, maintain regulatory compliance, and enhance the overall organizational performance [1-3].

TQM represents a holistic and organization-wide philosophy that emphasizes continuous improvement, customer satisfaction, and employee participation in quality-related activities [4, 5]. In parallel, FSM systems, including ISO 22000 and Hazard Analysis and Critical Control Points (HACCP), concentrate on the identification, assessment, and control of food safety hazards throughout the production process [6, 7]. Although each framework has been shown to independently improve organizational outcomes, the synergistic integration of TQM and FSM in the food industry, particularly within emerging economies, such as Thailand, has not been extensively examined.

This study seeks to address this gap by investigating the relationship between TQM and FSM practices and their combined impact on organizational performance. Drawing upon a comprehensive literature review and empirical evidence, the proposed conceptual framework highlights the key dimensions of TQM and FSM that may jointly contribute to improved financial, operational, and product quality outcomes. Focusing on the Thai food industry, this research contributes to the broader discourse in engineering and applied sciences by providing practical insights for managers and policymakers, which support the enhancement of organizational competitiveness through structured quality and safety management initiatives. The findings are expected to guide future empirical research and facilitate the development of integrated management strategies that align quality and safety objectives with overall performance goals.

A. Total Quality Management

TQM is a holistic management philosophy aimed at the continuous improvement of processes, products, and services to meet or exceed customer expectations. Grounded in the foundational theories of quality pioneers, such as Deming, Juran, and Crosby, TQM promotes organization-wide participation in quality enhancement by integrating key elements, such as leadership commitment, customer orientation, process management, employee involvement, data-driven decision-making, and continuous improvement.

In [8-10], it is emphasized that quality improvement should not be confined to production functions but rather implemented systematically across all organizational levels to ensure sustainable performance. In alignment with the Resource-Based View (RBV) of the firm, TQM is also regarded as a strategic capability that can create a sustained competitive advantage through effective quality management practices.

Empirical evidence indicates that the successful implementation of TQM contributes to improved operational efficiency, increased customer satisfaction, and enhanced overall organizational performance [4, 5, 11]. Within the food industry, where quality and safety are fundamental to consumer trust and regulatory compliance, TQM serves as a critical foundation for integrating quality management with food safety practices. This integration not only facilitates compliance with international standards but also strengthens the competitiveness of organizations in global markets [12].

B. Food Safety Management

FSM refers to the systematic implementation of policies, procedures, and practices designed to ensure that food products are safe for consumption and comply with regulatory as well as international standards. It plays a critical role in the food industry, where deficiencies in safety management may result in serious public health risks, financial losses, and reputational damage. Internationally recognized frameworks, such as Good Manufacturing Practices (GMP), HACCP, and ISO 22000, are widely adopted as integral components of FSM systems [13-15]. These frameworks emphasize proactive hazard identification, risk assessment, and preventive control measures across the entire food production and supply chain. Effective FSM extends beyond technical compliance, requiring strong organizational commitment, employee competency development, and alignment with broader quality management initiatives [16, 17]. In the Thai food industry the implementation of robust FSM practices is essential to maintaining competitiveness and meeting increasingly stringent international safety requirements.

C. Organizational Performance

Organizational performance is a multidimensional construct reflecting a firm's capacity to achieve the desired outcomes, including operational efficiency, product quality, financial performance, and customer satisfaction. According to the RBV and dynamic capabilities theory, intangible resources, such as effective management systems, can enhance performance and provide a sustainable competitive advantage. Within this context, both TQM and FSM represent strategic organizational capabilities that contribute to superior performance outcomes.

It has been indicated that the integration of TQM and FSM can generate benefits by improving process efficiency, ensuring product safety, enhancing regulatory compliance, and strengthening market reputation [3-5, 17]. In export-oriented economies, such as Thailand, achieving high organizational performance necessitates not only operational excellence and product quality but also strict adherence to the international food safety standards. Therefore, understanding the combined influence of TQM and FSM on organizational performance is vital for advancing both theoretical understanding and practical management applications within the food industry.

D. Structural Equation Modeling

SEM is an advanced statistical technique that enables the simultaneous examination of complex relationships among observed and latent variables within a theoretical framework. By integrating elements of factor analysis and multiple regressions, it allows researchers to estimate direct, indirect, and mediating effects among constructs. Unlike traditional regression approaches, SEM provides the capability to evaluate both measurement models, through Confirmatory Factor Analysis (CFA), and structural models within a single analytical process, ensuring construct validity and supporting causal inference. This methodological strength makes SEM particularly suitable for studies that investigate the theoretical relationships among management practices, organizational processes, and performance outcomes, as it accounts for measurement errors and unobservable latent constructs [18].

SEM has been used to analyze the interactions between TQM, Human Resource Management, and organizational performance [19, 20], offering a rigorous analytical framework for evaluating their individual and combined effects on organizational performance. This approach provides more comprehensive and reliable empirical evidence compared to conventional statistical methods. In this context, the present study employs SEM to validate the proposed conceptual model and to empirically examine how quality and safety management practices jointly contribute to enhancing organizational performance within the Thai food industry.

II. METHODOLOGY

A. Research Design

A quantitative research design was adopted in this study to examine the relationships among TQM, FSM, and organizational performance within the Thai food industry. So the proposed model was based on the framework described in [21], which investigates the influence of TQM practices and FSM on firm performance through multiple performance indicators.

The model consists of three latent constructs. The first is TQM and includes seven critical dimensions: Leadership, Customer Focus, Process Management, People Management, Information and Analysis, Strategic Planning, and Continuous Improvement. The second construct is FSM, and encompasses six essential factors: GMP, HACCP Team, Hazard Identification, Hazard Assessment, Hazard Control, and HACCP Knowledge. The third construct is Organizational Performance and is measured through three key indicators: Financial Performance, Operational Performance, and Product Quality.

The proposed integrative framework conceptualizes TQM as both a direct determinant of organizational performance and an enabler that strengthens FSM implementation and utilizes it as a mediating variable that links TQM to enhanced organizational outcomes. This perspective aligns with the dynamic capabilities theory, which emphasizes the importance of management practices in developing organizational capabilities that sustain competitive advantage and drive superior performance.

B. Hypotheses Development

The null hypothesis H_0 states that the key factors of TQM and FSM have no significant influence on organizational performance. In contrast, three alternative hypotheses were proposed:

- H_1: TQM has a direct and indirect influence and is positively associated with organizational performance.
- H_2: TQM has a direct and positive influence on FSM implementation.
- H_3: FSM has a direct and positive influence on organizational performance.

C. Population and Sample

The target population consisted of 1,127 food manufacturing firms in Thailand certified under recognized quality and food safety standards, including ISO 9001, ISO 22000, HACCP, and GMP, which were selected due to their established implementation of TQM and FSM practices. Since SEM requires a sufficiently large sample size to ensure statistical reliability, established guidelines propose a minimum of 200 participants or approximately 10 to 20 times the number of observed variables [18]. In this study, 16 observed variables were identified, so the sample size was calculated at 19 times this number, resulting in 304 participants, who consisted of quality managers, production supervisors, and senior operational staff. A total of 375 structured questionnaires were distributed, of which 304 valid responses were received, with a response rate of 81.1%. This sample size meets the proposed limits for SEM, ensuring sufficient statistical power.

D. Instrument Development and Data Collection

A structured questionnaire was developed as the primary research instrument to collect data on the three main constructs of the study. The measurement items were adapted from well-established scales used in previous studies and refined to fit the specific context of the Thai food industry.

It was organized into four sections: Respondent and firm demographic information, TQM practices, FSM practices, and Organizational performance. All items were measured using a five-point Likert scale, ranging from 1: strongly disagree to 5: strongly agree, allowing respondents to express varying degrees of agreement with each statement.

Prior to the full-scale data collection, a pilot study was conducted with 30 participants to ensure the clarity, relevance, and reliability of the items. The pilot test produced a Cronbach's alpha (α) coefficient of 0.896, indicating a high level of internal consistency and confirming the reliability of the instrument for subsequent large-scale distribution [22].

Data were collected through a combination of online survey forms and printed questionnaires over a three-month period. Participants were informed of the academic purpose of the study, confidentiality was ensured, and informed consent was obtained from all 304 respondents.

III. DATA ANALYSIS

Before conducting the SEM analysis, preliminary data screening and correlation testing were performed using SPSS to evaluate the linear relationships among the observed variables associated with TQM, FSM, and organizational performance. The Spearman rank correlation coefficients were calculated to determine both the strength and direction of these associations.

The results revealed statistically significant and positive correlations among the 120 observed variables at the 0.01 significance level, with coefficients ranging from 0.242 to 0.880, confirming satisfactory internal consistency within each construct. Specifically, ten pairs of variables demonstrated very high correlations with r_s greater than 0.8, fifty-eight pairs showed high correlations with r_s between 0.6 and 0.8, and forty-four pairs exhibited moderate correlations with r_s between 0.4 and 0.6. The weakest positive relationship, which had r_s=0.242 was found between information and analysis (TQM5) and hazard identification (FSM4), whereas the strongest with r_s=0.880 was observed between HACCP knowledge (FSM3) and hazard assessment (FSM5).

110 out of the 120 correlations did not exceed 0.80, so no multi-collinearity problems were identified, confirming that the dataset was suitable for SEM analysis. The other 10 pairs showed a high correlation with r_s greater than 0.80, indicating potential redundancy. To improve model parsimony and interpretability, the following four observed variables were excluded from further analysis: HACCP knowledge, hazard identification, hazard assessment, and hazard control.

After these adjustments, a second correlation test was conducted on the remaining twelve variables (Figure 1). The results confirmed strong and coherent interrelationships. Bartlett's Test of Sphericity with $\chi^2 = 3849.748$, df = 66, and $p < 0.001$, rejected the null hypothesis of an identity matrix, and the Kaiser-Meyer-Olkin (KMO) value of 0.919 indicated excellent sampling adequacy. These results verified that the data meet the statistical assumptions required for factor analysis and SEM.

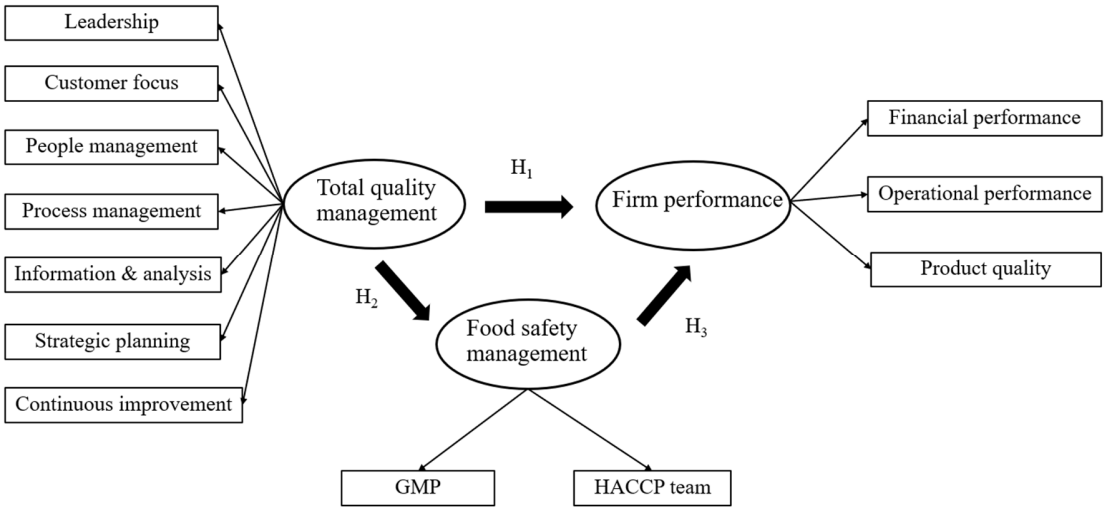

Fig. 1. Adjusted research model.

SEM analysis was then performed using LISREL 8.80 software to validate the proposed research framework and test the study's hypotheses. A CFA was conducted to assess the validity and fitness of the measurement model. The TQM measurement model exhibited an excellent fit, with χ^2=0.08, df=3, and p=0.99385. The Root Mean Square Error of Approximation (RMSEA) was 0.000, while both the Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI) reached 1.00. Similarly, the FSM model achieved strong fit indices with χ^2=0.21, df=1, p=0.64923, RMSEA=0.000, GFI=1.00, and AGFI=1.00. The organizational performance construct also showed an acceptable model fit with χ^2=0.66, df=1, p=0.41534, RMSEA=0.000, GFI=1.00, and AGFI=0.99.

The results (Table I) confirm that the proposed structural model demonstrates an excellent fit with the empirical data.

TABLE I. MODEL FIT

GFIs	Acceptable fit indices	Results
χ^2 /df (5.20/12)	< 2.00	pass
CFI (Comparative Fit Index)	> 0.95	pass
GFI	≥ 0.95	pass
AGFI	≥ 0.90	pass
RMSEA	< 0.05	pass
SRMR (Root Mean Square Residual)	< 0.05	pass

All indices meet or exceeded the proposed thresholds for model adequacy: χ^2/df=0.433, CFI=1.00, GFI=1.00, AGFI=0.98, RMSEA=0.000, SRMR=0.0066. These findings support the robustness of the conceptual framework, validating the interrelationships among TQM, FSM, and organizational performance in the Thai food industry context.

Reliability was assessed using Cronbach's alpha (α) coefficient, which ranged from 0.782 to 0.955 (Table II), exceeding the proposed threshold of 0.70 [16, 17]. These values confirm a strong internal consistency, indicating that the measurement items consistently captured their intended constructs.

TABLE II. FACTORS LOADING AND RELIABILITY ANALYSIS.

Scale	Items	Factor loading	Cronbach's alpha (α)	AVE	CR
Total quality management: TQM	Leadership	0.731	0.917	0.742	0.967
	Customer focus	0.784	0.782		
	Process management	0.801	0.895		
	People management	0.809	0.877		
	Information and analysis	0.798	0.918		
	Strategic planning	0.759	0.914		
	Continuous improvement	0.767	0.940		
Food safety management: FSM	GMP	0.881	0.854	0.861	0.925
	HACCP team	0.890	0.861		
Organizational performance: PER	Financial Performance	0.537	0.868	0.807	0.925
	Operational Performance	0.728	0.954		
	Product quality	0.724	0.955		

Convergent and discriminant validity were examined using the Average Variance Extracted (AVE) and Composite Reliability (CR). An AVE value above 0.50 indicates [18] that a construct explains a sufficient proportion of variance in its

observed indicators. The results showed AVE values ranging from 0.742 to 0.861, with CR values above 0.90, confirming excellent construct validity and reliability.

The SEM results (Table III), demonstrate that all hypothesized paths were statistically significant with $p<0.001$. TQM exhibited strong positive effects on both FSM and organizational performance, with standardized coefficients of 0.77, 0.67, and an indirect effect of 0.10 through FSM. FSM also had a positive direct influence on organizational performance, with $\beta=0.14$ and $p<0.01$.

TABLE III. STANDARD ESTIMATION OF THE MAIN MODEL

Path	DE	IE	TE
TQM→FSM	0.77	-	0.77
TQM→PER	0.67	0.10	0.77
FSM→PER	0.14	-	0.14
TQM→FSM→PER	0.77	0.10	0.77
PER: Firm performance; DE: Direct Effect; IE: Indirect Effect; TE: Total Effects			

The weights of the observed variables (Table IV) ranged from 0.75 to 1.00, being all significant at the 0.01 level, confirming strong measurement reliability. The coefficient of determination R^2 values ranged from 0.56 to 0.98, further supporting the robustness of the measurement model.

TABLE IV. WEIGHTS OF THE OBSERVED VARIABLES

Observed variables	Weight	R2
TQM1: Leadership	0.89	0.80
TQM2: Customer focus	0.84	0.71
TQM3: Process management	0.87	0.75
TQM4: People management	0.76	0.58
TQM5: Information and analysis	0.82	0.67
TQM6: Strategic planning	0.88	0.77
TQM7: Continuous improvement	0.91	0.83
FSM1: GMP	0.94	0.86
FSM2: HACCP team	0.95	0.86
PER1: Financial performance	0.75	0.56
PER2: Operational performance	0.95	0.88
PER3: Product quality	1.00	0.98

Applying the hypothesized structural model (Figure 2) yielded results that provided empirical support for rejecting the null hypothesis H_0, which stated that TQM and FSM exert no significant influence on organizational performance.

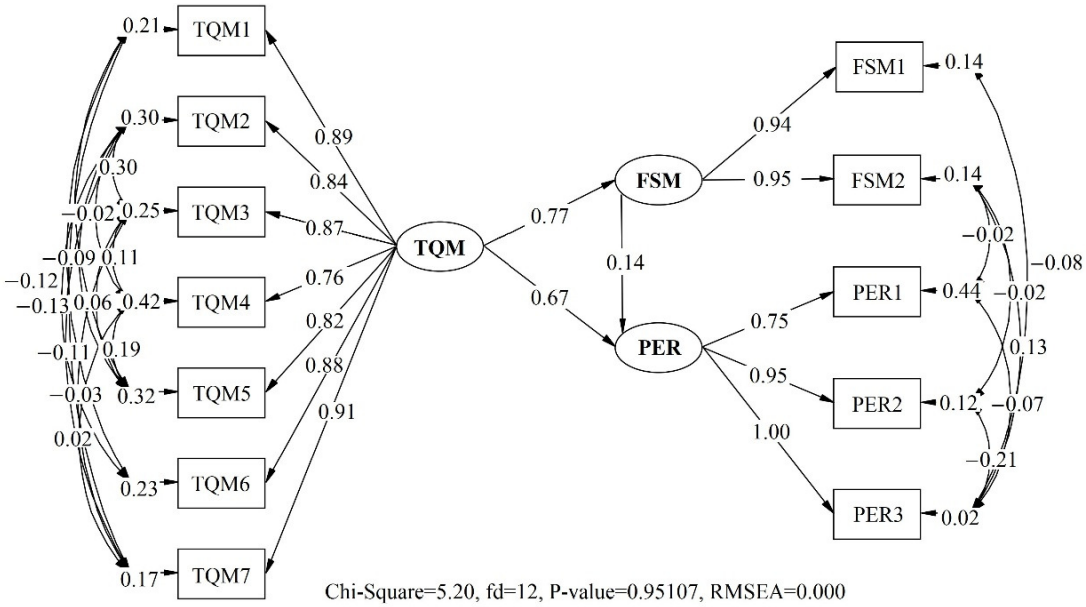

Fig. 2. The hypothesized structural model.

Three alternative hypotheses were confirmed:

- H_1: TQM has both direct and indirect positive effects on organizational performance. The results confirm the direct effect with a standardized coefficient $\beta=0.67$, and the indirect effect via FSM with a coefficient of 0.10 and $p<0.01$.
- H_2: TQM significantly and positively influences FSM implementation. The results showed a positive relation with $\beta=0.77$ and $p<0.01$.
- H_3: FSM directly and positively affects organizational performance. The results confirm the hypothesis with $\beta=0.14$ and $p<0.01$.

These results reinforce the integrated role of quality and FSM in improving organizational performance and suggest that an effective implementation of TQM enhances FSM practices, which in turn contribute to better operational efficiency, product quality, and overall competitiveness in Thailand's food industry.

IV. DISCUSSION

This study examined how TQM and FSM jointly influence organizational performance in Thailand's food industry using SEM. The analysis produced strong empirical evidence supporting all three hypotheses, confirming that TQM not only has a direct positive effect on performance but also indirectly enhances it through FSM. These results demonstrate that quality and safety management systems operate synergistically, reinforcing each other to drive superior organizational outcomes, which is a critical insight for companies competing in both domestic and global food markets.

The findings reveal that leadership, customer focus, process management, people management, information and analysis, strategic planning, and continuous improvement significantly and directly influence performance, with a coefficient β=0.67. In addition, TQM indirectly improves performance through FSM implementation, with a coefficient of 0.10 and $p<0.01$. This interaction aligns with the dynamic capabilities theory, suggesting that TQM enables organizations to adapt, learn, and build competencies that enhance both operational and strategic results [23-25]. The strong relationship between TQM and FSM further underscores that an effective quality management foundation is vital for ensuring food safety compliance and operational excellence.

Also FSM demonstrated a direct positive effect on organizational performance with a coefficient of 0.14 and $p<0.01$, highlighting the importance of practices, such as GMP and the establishment of competent HACCP teams. This supports earlier research emphasizing that well-designed food safety systems not only protect consumers but also strengthen firm reputation, efficiency, and international market access [26-28].

Based on these findings, a guide to integrating TQM and FSM is proposed:

- Strategic Alignment: Senior management should embed quality and food safety into corporate strategy, supported by a clear policy and a gap analysis against standards, such as ISO 9001, ISO 22000, and HACCP.
- System Integration: Documentation and process management systems should be unified to jointly address quality and safety requirements, minimizing redundancy and promoting efficiency.
- Capability Development: Cross-functional training and the creation of integrated quality–safety teams will enhance employee competence and facilitate effective implementation.
- Performance Management: Establishing shared Key Performance Indicators (KPIs) for quality and food safety, supported by periodic reviews, can promote accountability and continuous improvement.

Despite the robustness of the findings, this study has several limitations. First, the data were drawn exclusively from the Thai food industry, which may limit generalizability to other sectors or regions with different cultural and regulatory environments, so future research could apply the model to other developing economies or industrial contexts for comparative validation. Second, the use of a cross-sectional design limits causal interpretation. Longitudinal studies could explore how the integration of TQM and FSM evolves over time and how these practices sustain performance improvements. Finally, this research relied on quantitative methods, so complementary qualitative approaches, such as in-depth case studies or interviews, could provide deeper insights into organizational culture, implementation challenges, and contextual factors influencing success. A mixed-method approach would, therefore, offer a richer and more comprehensive understanding of how quality and safety systems jointly enhance performance.

V. CONCLUSIONS

This research provides empirical evidence that integrating Total Quality Management (TQM) and Food Safety Management (FSM) significantly improves organizational performance within Thailand's food industry. TQM exerts both direct and indirect effects on performance, while FSM serves as a mediating factor that strengthens this relationship. Together, these systems form a complementary framework that enhances product quality, operational efficiency, and regulatory compliance.

The results confirm that organizations adopting TQM principles, supported together by strong leadership, customer orientation, process discipline, and continuous improvement, are better equipped to implement effective FSM systems. In turn, robust FSM practices, such as GMP and HACCP, enhance product safety and market competitiveness. The importance of integrating quality and safety management as a unified strategic system is also underscored. For industry leaders, this means investing in training, system integration, and aligned performance metrics. For policymakers, it highlights the value of promoting education, incentives, and knowledge-sharing to strengthen food sector competitiveness.

In conclusion, the synergy between TQM and FSM offers a sustainable path toward improved organizational performance and industry advancement. Future studies should continue exploring this integration across industries and time horizons to further enrich theoretical understanding and practical application in quality and safety management.

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