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A Causal Relationship Between Quality Management and Lean Production Affecting Management Efficiency in Thailand's Computer Equipment Industry

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Abstract—*This study aims to investigate the causal relationship between Total Quality Management (TQM) and Lean Production (LP) and their effects on management efficiency in Thailand's computer equipment industry. The research objectives were: (1) to analyze the conceptual and theoretical components of enterprise-wide TQM and LP systems, (2) to identify interconnections between these systems and management efficiency, and (3) to develop a conceptual framework for empirical validation. A total of 40 firms were selected as samples, and data were collected through a structured questionnaire. Statistical tools included descriptive statistics and Structural Equation Modeling (SEM). The findings revealed that TQM has a direct positive influence on management efficiency ($\beta = 0.418$, $p < 0.01$) and a significant relationship with lean production ($\beta = 0.342$, $p < 0.01$). Moreover, lean production has a strong direct effect on management efficiency ($\beta = 0.594$, $p < 0.001$). The overall model fit was satisfactory ($\chi^2/df = 1.98$, GFI = 0.94, AGFI = 0.91, RMSEA = 0.045). These results indicate that effective integration of TQM and LP practices enhances organizational performance, operational efficiency, and sustainable competitiveness.*

Keywords— *Total Quality Management, Lean Production, Management Efficiency, Computer Equipment Industry, Thailand.*

I. INTRODUCTION

The modern industrial environment is characterized by rapid technological change, increasing competition, and the demand for high-quality products at lower costs. Within this context, Total Quality Management (TQM) and Lean Production (LP) have emerged as two crucial management philosophies. TQM emphasizes continuous improvement, customer satisfaction, and employee involvement, whereas LP focuses on eliminating waste, optimizing processes, and enhancing value creation.

Thailand's computer equipment industry represents a significant sector contributing to national economic growth. However, many firms face challenges related to productivity, quality consistency, and cost management. Therefore, understanding how TQM and LP influence management efficiency is essential for sustaining competitiveness.

II. LITERATURE REVIEW

The concepts of Total Quality Management (TQM) and Lean Production (LP) have attracted considerable scholarly and practical attention over the past few decades, as both aim to enhance operational performance and reduce waste across organizational processes. Fundamentally, both approaches share common objectives of continuous improvement and waste reduction, which are essential for achieving long-term competitiveness and customer satisfaction.

Total Quality Management (TQM) focuses on managing quality across all organizational functions by engaging employees at every level, fostering a culture of continuous improvement, and relying on data-driven decision-making (Deming, 1986; Juran, 1995). It is a process-oriented and people-driven philosophy that emphasizes leadership commitment, teamwork, process control, and customer satisfaction. TQM views quality as everyone's responsibility and aims to build an organizational culture that prioritizes excellence and continuous learning.

In contrast, Lean Production (LP) - rooted in the Toyota Production System (TPS) - focuses on improving system efficiency and operational flow by eliminating all forms of non-value-adding activities (Womack & Jones, 1996). Lean seeks to deliver customer value through streamlined processes, reduced lead times, and optimal use of resources. It provides a set of practical tools and techniques such as Just-in-Time (JIT), 5S, Value Stream Mapping (VSM), and Kaizen to systematically identify and eliminate waste.

Although TQM and LP differ in emphasis - TQM focusing on people and processes, while LP emphasizes system design and flow - they are philosophically aligned in their pursuit of operational excellence. Both stress the importance of customer orientation, employee involvement, and a culture of continuous improvement (Shah & Ward, 2003; Alireza Anvari, 2011).

According to Shah and Ward (2011), integrating TQM principles into lean initiatives creates a synergistic effect that enhances overall operational performance. They argued that TQM provides the cultural and managerial foundation—including leadership, employee engagement, customer focus, and data-based decision-making—that supports the effective implementation of lean systems. Similarly, Alireza Anvari (2011) emphasized that TQM and Lean are structurally interrelated, suggesting that TQM acts as an enabler that helps Lean practices become more sustainable and effective. He

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proposed that Lean should not be seen merely as a set of tools but as a mindset supported by the values and principles of TQM.

Subsequent research has provided further empirical evidence for this integration. Studies indicate that organizations adopting both TQM and Lean approaches tend to outperform those implementing either approach in isolation (Bortolotti et al., 2015). Lean contributes process efficiency and operational agility, while TQM establishes a people-centered culture that sustains improvement initiatives. When combined, they create a balanced system that not only reduces waste and cost but also improves quality, delivery performance, and long-term competitiveness.

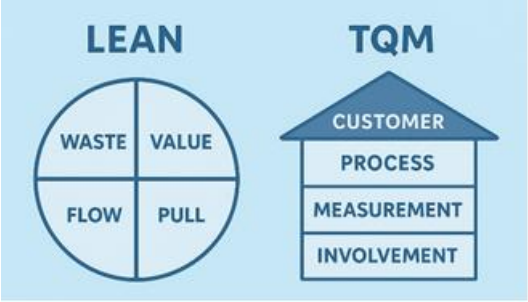

Fig. 1. Comparison Between Lean and TQM

Short Description: The image illustrates the concept of the Just-In-Time system, featuring a clock symbolizing on-time delivery and a conveyor belt with boxes representing production based on demand to reduce waste and increase efficiency.

Fig. 2. Just-In-Time (JIT) System

Short Description: An infographic illustrating the differences between Lean and TQM — Lean focuses on eliminating waste and creating value, while TQM emphasizes overall quality management through process control, measurement, and involvement of everyone in the organization.

III. Research Objectives and Hypotheses

Objectives:

1. To examine the relationship between TQM and management efficiency.
2. To investigate the relationship between TQM and lean production.
3. To assess the effect of lean production on management efficiency.

Hypotheses:

- H1: TQM positively influences management efficiency.
- H2: TQM positively influences lean production.
- H3: Lean production positively influences management efficiency.

IV. Research Methodology

4.1 Research Design

This research adopted a quantitative design with supportive qualitative validation. The study utilized a causal research approach to examine relationships between Total Quality Management (TQM), Lean Production (LP), and Management Efficiency (ME). The conceptual framework was developed based on previous empirical studies and theoretical models of continuous improvement and process optimization.

4.2 Population and Sample

The population in this study consisted of all computer equipment manufacturing companies located in Thailand. Due to the limited accessibility of the entire population, a purposive sampling method was used to select 40 firms that actively implement either TQM or Lean practices. The unit of analysis was the management level personnel - such as production managers, quality control officers, and process engineers - who are directly involved in implementing these systems.

4.3 Research Instruments

Data were collected through a structured questionnaire developed from validated scales in previous studies. The questionnaire consisted of five sections:

1. Demographic information (organization size, position, years of operation).
2. Total Quality Management (TQM) – measured using 9 dimensions: leadership, employee engagement, customer focus, training, process management, data analytics, strategic planning, supplier relationship, and continuous improvement.
3. Lean Production (LP) – assessed by indicators such as pull production, just-in-time (JIT), waste reduction, and continuous flow systems.
4. Management Efficiency (ME) – evaluated through productivity, quality, cost reduction, and flexibility.

Open-ended questions for qualitative insights.

4.4 Data Collection Procedure

Data were collected through both online and onsite surveys between January and May 2025. Respondents were contacted through professional networks and industrial associations. Each participant was informed of the study's purpose and confidentiality policy.

4.5 Data Analysis

Data were analyzed using appropriate statistical techniques. The following procedures were applied:

1. Descriptive Statistics - including frequency, percentage, mean, and standard deviation to describe and summarize demographic characteristics.
2. Reliability and Validity Testing - Cronbach's alpha was used to assess internal consistency, and confirmatory

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factor analysis (CFA) was conducted to evaluate construct validity.

3. Correlation Analysis - performed to examine the relationships among the study variables.

Structural Equation Modeling (SEM) - applied to test the hypothesized causal relationships among variables.

V. Research Results

5.1 Descriptive Statistics

A total of 40 computer equipment manufacturing companies participated in the study. Among respondents, 55% were production managers, 30% were quality control officers, and 15% were process engineers. Most firms had operated for more than 10 years (62.5%), and 70% reported having implemented both TQM and Lean systems for at least three years.

5.2 Reliability and Validity

The questionnaire's reliability was confirmed using Cronbach's Alpha, showing strong internal consistency across all constructs:

- Total Quality Management (TQM): $\alpha = 0.921$
- Lean Production (LP): $\alpha = 0.894$
- Management Efficiency (ME): $\alpha = 0.913$

All values exceeded the acceptable threshold of 0.70, indicating excellent reliability. Confirmatory Factor Analysis (CFA) results also indicated a good model fit ($\chi^2/df = 1.98$, GFI = 0.94, AGFI = 0.91, RMSEA = 0.045).

5.3 Correlation Analysis

The Pearson correlation coefficients showed significant positive relationships among the three main variables ($p < 0.01$).

- TQM and LP: $r = 0.68$
- TQM and ME: $r = 0.59$
- LP and ME: $r = 0.72$

5.4 Hypothesis Testing Using SEM

TABLE 1. The results of Structural Equation Modeling (SEM) revealed that all hypotheses were supported:

Hypothesis	Relationship	Path Coefficient (β)	Result
H1	TQM → ME	0.418*	Supported
H2	TQM → LP	0.342*	Supported
H3	LP → ME	0.594**	Supported

*p < 0.05, **p < 0.001

5.5 Model Fit and Interpretation

The final model demonstrated a good overall fit with the empirical data ($\chi^2/df = 1.98$, GFI = 0.94, CFI = 0.96, RMSEA = 0.045). The findings suggest that Lean Production mediates the relationship between Total Quality Management and Management Efficiency, indicating that firms achieving higher quality management implementation also tend to optimize their lean systems, leading to enhanced operational performance.

VI. Discussion

The findings of this study reveal that Total Quality Management (TQM) and Lean Production (LP) both have significant positive impacts on Management Efficiency (ME) within Thailand's computer equipment manufacturing industry. Moreover, Lean Production acts as a mediating variable, bridging the influence of TQM toward management efficiency. These results align with previous studies such as *Anvari (2011)* and *Tiwari (2021)*, which highlight that the integration of quality management systems and lean methodologies enhances operational performance and competitive advantage.

6.1 The Role of Total Quality Management

The path coefficient between TQM and ME ($\beta = 0.418$, $p < 0.05$) indicates that effective quality management practices—such as leadership commitment, continuous improvement, and employee engagement—directly enhance management efficiency. Organizations that promote a culture of quality across all departments achieve better communication, process alignment, and customer satisfaction.

6.2 The Mediating Role of Lean Production

The study confirmed that Lean Production significantly mediates the effect of TQM on Management Efficiency. This suggests that firms emphasizing quality management naturally implement lean principles such as waste minimization, just-in-time systems, and continuous flow production, which in turn streamline operations and reduce inefficiencies.

6.3 Theoretical Implications

This research strengthens the theoretical link between Quality Management Theory and Lean Production Philosophy, demonstrating that both frameworks share a common foundation—continuous improvement and value creation. The integration of these two approaches supports the systems theory perspective, which views an organization as an interconnected network of processes where improvement in one area can positively affect the entire system.

6.4 Managerial Implications

For practitioners, the findings highlight the importance of integrating TQM and Lean Production rather than implementing them separately. Managers should focus on developing leadership commitment, employee training, and cross-functional collaboration to ensure both quality and efficiency objectives are met. The adoption of lean practices guided by strong quality management systems can lead to cost reduction, faster response to market demands, and sustainable competitiveness.

VII. Conclusion and Recommendations

Conclusion:

The study investigated the causal relationship between Total Quality Management (TQM), Lean Production (LP), and Management Efficiency (ME) within Thailand's computer equipment manufacturing industry. The results clearly demonstrate that TQM has both direct and indirect positive effects on management efficiency through the mediating influence of lean production.

Specifically, the study found that:

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1. TQM directly enhances management efficiency ($\beta = 0.418$, $p < 0.05$) through leadership, process control, and employee involvement.
2. TQM strongly supports Lean Production ($\beta = 0.342$, $p < 0.05$), suggesting that effective quality management naturally promotes lean practices.
3. Lean Production has the highest influence on management efficiency ($\beta = 0.594$, $p < 0.001$), indicating that efficient resource utilization and waste minimization are critical success factors.

These findings collectively emphasize that TQM and Lean Production are complementary strategies. Integrating them creates a synergistic effect, enabling organizations to achieve superior performance in productivity, quality, and customer satisfaction.

A. Managerial Recommendations

1. Integrate TQM and Lean systems: Organizations should implement quality management principles alongside lean tools to enhance operational synergy.
2. Focus on leadership and employee engagement: Empowering employees and maintaining top-management commitment are essential to sustain improvement initiatives.
3. Enhance data-driven decision making: Using analytics to monitor production and quality performance can reduce errors and improve process consistency.
4. Promote continuous learning and training: Ongoing development programs strengthen workers' adaptability to new lean and quality techniques.

B. Policy and Industry Recommendations

1. The Thai government and industrial associations should encourage Lean–TQM integration programs through training subsidies and benchmarking platforms.
2. Policies should support digital transformation in manufacturing, allowing firms to implement data analytics and quality monitoring systems.
3. Collaborative networks between academia and industry should be strengthened to promote research-based quality and productivity improvement initiatives.

C. Future Research Recommendations

1. Future studies could expand the model to other industries such as electronics or automotive to compare the universality of the causal relationships.
2. Longitudinal studies are recommended to examine how sustained TQM–Lean integration impacts performance over time.
3. Further research could incorporate qualitative methods such as interviews and case studies to explore organizational culture and leadership influence more deeply.

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