International Research Journal of Multidisciplinary Scope (IRJMS), 2026; 7(2): 1531-1547 IRJMS

Original Article | ISSN (O): 2582-631X DOI: 10.47857/irjms.2026.v07i02.09130

Does Lean Manufacturing Practices Improve Firm Performance: Mediating Role of Competitive Advantages?

Hoang Thi Huong[1]*, Nguyen Thi Trang Nhung[1], Nguyen Thi Van Anh[1], Hoang Van Hoanh[2], Nguyen Duy Chuc[1], Le Thi Hai[1]

[1]School of Economics, Hanoi University of Industry, Hanoi, Vietnam, [2]School of Information and Communications Technology, Hanoi University of Industry, Hanoi, Vietnam. *Corresponding Author's Email: hoanghuongcn@gmail.com, huonght@haui.edu.vn

Abstract

In today's rapidly evolving and competitive business environment, manufacturing enterprises are striving to enhance productivity, reduce waste and maintain sustainable competitiveness. Lean manufacturing has emerged as a vital approach that focuses on maximizing value while minimizing the use of resources, thereby improving operational efficiency and firm performance. This study examines the impact of lean manufacturing practices on firm performance through the mediating role of competitive advantage. Data were collected from 248 manufacturing firms in Northern Vietnam and analysed using Smart PLS 4 software to test the proposed research model. The findings indicate that five of the seven dimensions of lean manufacturing, including process and equipment, planning and control, human resource management, product design and supplier relationships, significantly improve firm performance. Furthermore, the results confirm that competitive advantage mediates the relationship between lean manufacturing and firm performance, showing that lean practices contribute to better performance by strengthening a firm's competitive position. These results also highlight the importance of integrating lean principles into strategic decision-making, particularly in emerging economies where resource constraints and operational inefficiencies are common challenges. By adopting lean tools and techniques, firms can streamline workflows, enhance coordination across departments and foster a culture of continuous improvement. Additionally, the study underscores the role of collaboration with suppliers and investment in workforce capabilities as essential drivers of sustainable operational excellence.

Keywords: Competitive Advantage, Firm Performance, Lean Manufacturing Practices, Manufacturing Firms, Northern Vietnam.

Introduction

In the current context of globalization, as countries continuously engage in free trade agreements (FTAs), numerous opportunities arise for manufacturing enterprises (1). FTAs remove tariff and technical barriers, expanding market access but also intensifying competition as firms face a broader range of rivals (2, 3). This compels them to make strategic changes to strengthen their competitiveness and market value (4). Specifically, enterprises need to adopt new production methods to increase product value while reducing the consumption of input resources. In this context, lean manufacturing (LM) has emerged as an effective approach that helps enterprises reduce production and operational costs, thereby improving their competitiveness and overall performance (5-7). The concept of "lean manufacturing" or "lean production" has been defined in many different ways by scholars, yet the concept still lacks a universally accepted definition (8). In general, lean manufacturing can be understood as a production philosophy and management system aimed at eliminating waste, optimizing processes and creating maximum value for customers, thereby enhancing competitiveness (9). LM particular emphasis on value stream flow, striving for continuous and sequential production across stages (10). As a result, firms can increase productivity, improve product or service quality, reduce production costs and shorten production cycles (11). More importantly, lean enables enterprises to respond more quickly to customer needs, thereby enhancing competitive advantage and strengthening their market position (5, 11). In this study, lean manufacturing is assessed across seven dimensions (10). This includes: process and equipment (PE), planning and control (PC),

(Received 11th November 2025; Accepted 12th March 2026; Published 24th April 2024)

human resource management (HR), visual information system (VIS), product design (PD), supplier relationship (SR) and customer relationship (CR). Evaluating LM through these seven dimensions provides a more comprehensive understanding of its role, allowing managers to design targeted strategies for each aspect to improve implementation effectiveness.

Furthermore, this approach helps clarify the mediating mechanism of competitive advantage, an area that has been underexplored in previous research. Competitive advantage (CA) refers to the distinctive attributes or actions that enable a firm to outperform its rivals in the market (12). CA emerges when a company achieves higher profitability or performance compared to its competitors (13). This superiority can be reflected in pricing, product quality, or service, which encourages customers to prefer the firm over others. In short, CA must be continuously maintained within every organization, as higher competitiveness leads to better overall performance (14). In summary, competitive advantage can indeed be developed through LM activities (15).

The role of LM has been widely examined by scholars in recent years, highlighting its importance in business and production activities. In the context of Indian, small and medium-sized enterprises (SMEs) showed that lean manufacturing enhances operational performance (16). This finding is consistent context in China, where LM also improves product research and development performance, thereby strengthening the core value creation (17). In the Vietnamese context, some studies conducted literature-based studies identifying both barriers and facilitators to lean implementation, including factors such as organizational culture, leadership awareness and employee skills (18, 19). However, empirical evidence on the relationship between LM and FP in Vietnam remains scarce. Several studies have shown that LM can enhance firm performance (FP) through various mediating mechanisms such as organizational culture, sustainable leadership (7), supply chain management (20, 21), accounting practices (22), lean culture (5, 23) and managerial dimensions (24). However, no study has yet provided empirical evidence on the mediating role of CA. Although many scholars have confirmed that the implementation of LM helps firms reduce costs, improve quality and customer responsiveness. These improvements may do not directly impact financial outcomes or overall performance. Instead, they are transformed into competitive advantages in cost and quality in the market (6, 25). By simultaneously combining advantages in cost and quality, LM creates a competitive capability for firms (26).

Another research gap that should be addressed concerns how previous studies have measured the LM construct. Most prior research has treated LM as a single variable measured through overall scales consisting of 6–7 items (27-29). While this provides a general understanding of the role of LM, it fails to capture its specific dimensions. Such an approach can limit the managerial implications that firms can derive from the findings. Several scholars have suggested that LM should instead be assessed through multiple dimensions, including process, equipment, product design, visual management, workforce management and external relationships (20).

This study contributes to the literature by addressing three key gaps. First, empirical evidence on LM in the Vietnamese context remains limited, particularly among manufacturing firms in an emerging economy. Second, prior research has often treated LM as a single construct, whereas this study examines its distinct dimensions to provide more detailed managerial insights. Third, unlike previous studies focusing on other mediators, this research is the first to empirically test the mediating role of competitive advantage in the relationship between Lean Manufacturing and firm performance.

In this study, the Dynamic Capability Theory (DCT) is employed (30). Lean practices reflect a firm's dynamic capabilities in optimizing processes, enhancing workforce capabilities, strengthening supply chain connections. Through these practices, firms develop the abilities to sense, seize and reconfigure resources to enhance operational effectiveness. Thus, the LM to CA to FP model in this study clearly illustrates how firms transform operational improvements from LM into CA and FP. This theoretical alignment is particularly relevant for manufacturing firms in Vietnam, which are striving to build innovation capacity and agility in a rapidly changing market environment.

Hypotheses Development

Process and equipment are defined as the aspect of Lean Manufacturing that ensures quality standards are maintained while minimizing setup time to achieve continuous flow production (8). In Pakistan context, Process and Equipment has a positive impact on the sustainable performance of manufacturing firms (20). When firms possess well-structured processes and appropriate equipment, they can reduce input material consumption and minimize product defects during production (8). This leads to significant cost savings, shorter repair times and fewer corrective actions. Empirical evidence also shows that applying Process and Equipment helps shorten setup time, creates a smoother production flow and reduce error-handling (5). However, the effectiveness of process and equipment improvements may vary across firms. Substantial investments in advanced machinery and process reconfiguration can increase operational complexity and fixed costs. Based on these arguments, we hypothesize that:

Hypothesis 1: Process and Equipment have a positive impact on firm performance.

The application of Planning and control aims to synchronize production with market demand through proper production planning and scheduling. It includes practices such as level production (heijunka), small-lot production and pull systems (Kanban) to ensure a smooth flow of materials and products, avoid excess inventory and minimize imbalances along the production line (10). Moreover, implementing production planning and control activities helps firms reduce the consumption of raw materials and components while ensuring on-time delivery. The pull system also minimizes work-in-progress, saves floor space and reduces waste caused by defective products (31, 32). However, in the context of Vietnamese manufacturing firms, the implementtation of planning and control practices often faces practical constraints. Demand volatility, limited forecasting accuracy and unstable market conditions make it difficult for firms to align production schedules effectively (7). Based on these arguments, we hypothesize that:

Hypothesis 2: Planning and control have a positive impact on firm performance.

In lean manufacturing, the human resource management (HRM) dimension plays a crucial role. HRM in Lean Manufacturing encompasses activities related to managing and developing human resources to facilitate the successful implementation of lean principles (5, 23). It involves empowering employees, increasing their participation in continuous improvement processes, building self-managed teams, organizing training and skill development programs and establishing performance evaluation and reward systems (33, 34). The goal of HRM in lean implementation is to maximize human potential, foster motivation and commitment toward process improvement and thereby enhance overall quality, productivity and organizational performance (20). Based on these arguments, we propose the following hypothesis:

Hypothesis 3: HRM has a positive impact on firm performance.

The Visual Information System (VIS) refers to a system that provides visual information at the workplace to support quick and accurate decision-making (10). VIS typically includes tools such as information boards, production charts, signal lights, or Kanban cards that clearly and visibly communicate operational status, production progress and emerging issues (35). By facilitating quick feedback and reducing information delays, VIS helps eliminate waste, improve productivity and ultimately enhance organizational performance (36). Although VIS has been recognized as a key element of Lean, its relationship with firm performance has not yet been empirically explored in prior research, creating a significant empirical gap. Therefore, this study proposes the following hypothesis:

Hypothesis 4: Visual information system has a positive impact on firm performance.

Product design focuses on designing and developing products that not only meet customer needs but are also optimized for manufacturing efficiency (37). Research demonstrated a positive relationship between product design and firm performance, showing that attention to lean-oriented product design helps reduce costs, shorten development time and enhance quality from the early stages (38). This enables firms to respond more rapidly to market demands, create greater customer value and strengthen competitive advantage. This approach shortens development cycles, reduces production costs, minimizes manufacturing errors and ensures

product quality from the outset (39). As a result, firms not only deliver higher value to customers but also improve operational performance and reinforce their competitiveness in the market-place. Based on these arguments, we propose the following hypothesis:

Hypothesis 5: Production design has a positive impact on firm performance.

Supplier relationship emphasizes building and maintaining close, long-term and cooperative relationships with suppliers to improve supply chain efficiency (10). Key practices include transparent information sharing, on-time delivery assurance, joint product development, quality control of raw materials and collaboration in improvement activities. Unlike traditional supplier relations, lean supplier relationship focuses on trust-based, long-term partnerships, stable, low-cost process with significantly reduced logistics expenses (40). Establishing close supplier relationships allows both parties to gain a deeper mutual understanding, enabling suppliers to participate in firms' production improvement processes and contribute to developing products that better meet market demand (41). However, manufacturing firms in Vietnam often place limited emphasis on supply chain stability, as they tend to prioritize short-term profit optimization over long-term coordination and resilience (42, 43). Based on these arguments, we propose the following hypothesis:

Hypothesis 6: Supplier relationship has a positive impact on firm performance.

Customer relationship is a critical factor for the survival of any business. In lean manufacturing, firms must focus on developing stable and long-term relationships with customers to enhance their satisfaction with the company's products (5). Regular interaction with customers is also essential, as continuous feedback enables firms to identify customer needs promptly and improve product and service quality (44, 45). Indeed, strategic customer service orientation plays an important role in improving operational and business performance in manufacturing firms (46). Based on these arguments, we propose the following hypothesis:

Hypothesis 7: Customer relationship has a positive impact on firm performance.

Many prior studies have confirmed that LM improves firm performance by reducing waste, standardizing processes and increasing adaptability to environmental change (9, 11, 22). The mechanism of LM lies in creating advantages in cost, quality and supply chain efficiency, which collectively contribute to forming competitive advantage (CA) (6, 47). From the perspective of Dynamic Capability Theory (48), operational improvements achieved through LM are trans-formed into unique and inimitable capabilities that the market recognizes as CA. Once firms establish a competitive edge over their rivals, this logically translates into superior performance.

Recent research has also emphasized the strategic importance of CA. Studies demonstrated that CA positively affects firm performance and mediates relationships between organizational practices such as green innovation, TQM and SCM and firm outcomes (49). Similarly, other studies found that CA mediates the link between lean management, including just-in-time, supplier development and customer involvement and business performance (50, 51). These findings collectively support the idea that CA serves as a dynamic mechanism that transforms operational excellence into sustained performance advantages.

However, existing research still presents several important gaps. First, most studies have not comprehensively examined all key dimensions of LM, often treating it as a single aggregated construct. This limit understanding of which specific Lean practices drive performance improvements. Second, prior work has primarily focused on lean management rather than lean manufacturing, overlooking the production-side mechanisms that create real operational advantages. Third, there is a lack of empirical evidence from manufacturing enterprises in emerging economies such as Vietnam, where the intensity of market competition makes CA a critical channel through which LM improvements are converted into business performance. Based on these arguments, we propose the following hypotheses:

Hypothesis 8a: Competitive advantage has a positive effect on firm performance.

Hypothesis 8b: Competitive advantage mediates the relationship between lean manufacturing practices and firm performance.

Based on these arguments, we propose the following research model (Figure 1).

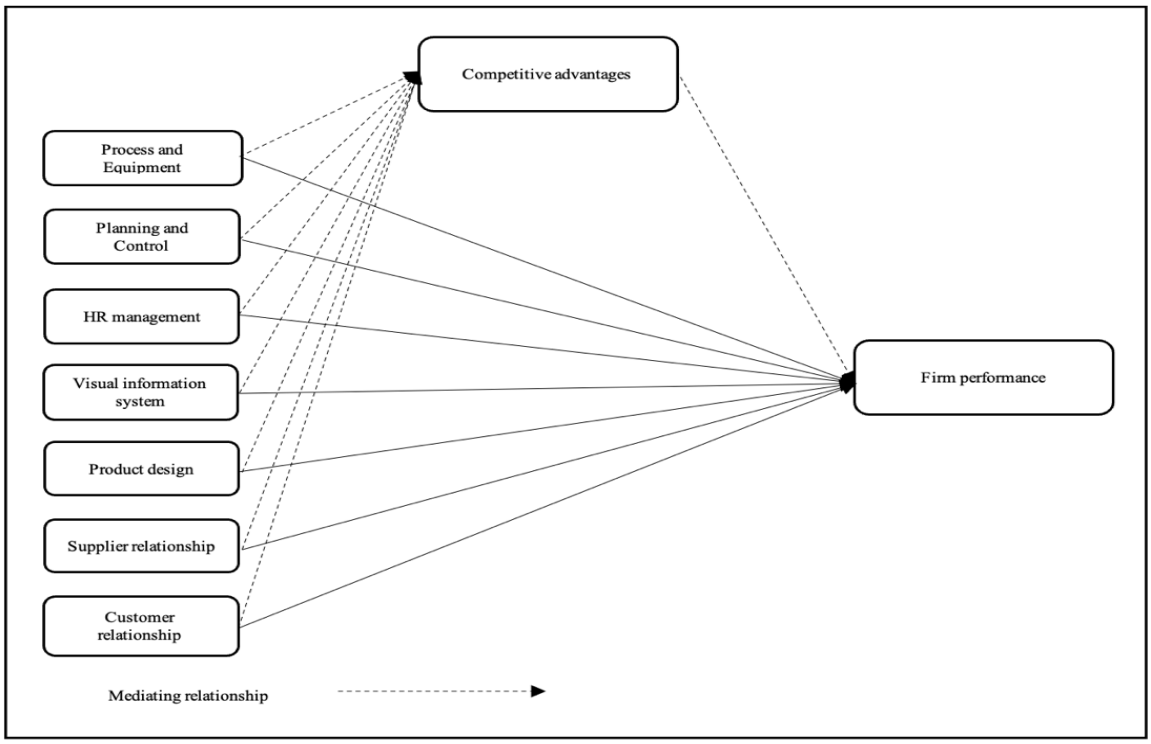

Figure 1: Impact of Lean Manufacturing Practices on Firm Performance Through Competitive Advantage

Methodology

Data collection and sampling

This study was conducted in the Northern region of Vietnam, which is characterized by a high concentration of industrial zones and manufacturing plants. A purposive sampling approach was employed to ensure the relevance and reliability of the collected data by targeting manufacturing firms that were currently implementing or had previously implemented lean manufacturing practices. To further enhance data credibility, only firms holding valid ISO certification were included in the sampling frame. The surveyed firms were located in provinces and cities with a high density of industrial parks, including Hanoi (21°01′42″ N, 105°51′12″ E), Bac Ninh (21°11′15″ N, 106°04′24″ E), Hai Phong (20°51′59″ N, 106°40′57″ E) and Hung Yen (20°51′16″ N, 106°00′58″ E). The details are presented in Figure 2.

Using existing professional networks and contact information obtained from business associations and social organizations in Northern Vietnam, an initial list of 600 small and medium-sized manufacturing enterprises was established. Firms that did not operate in manufacturing activities, respondents had no experience with lean manufacturing practices were excluded from the study.

Survey questionnaires were distributed to the selected enterprises between September 21 and October 25, 2025. To ensure response accuracy and consistency, respondents were required to have sufficient knowledge of lean manufacturing practices and at least three years of working experience within the same firm. Responses that did not meet these criteria or contained substantial missing information were removed during the screening process. To increase the response rate, the cover letter emphasized that all data would be kept strictly confidential, no identifying information would be collected and the information would be used solely for academic research purposes.

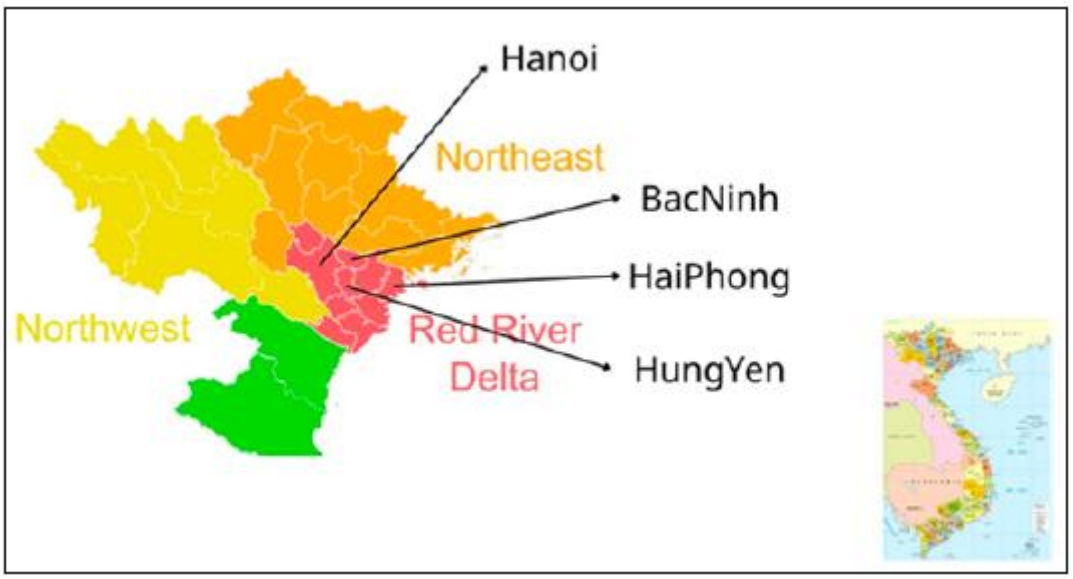

Figure 2: Locations of the Sampling Areas

In addition, a reminder system was implemented to monitor responses and encourage timely participation. At the end of the data collection process, 400 questionnaires were returned. After data extraction, screening and validation, 248 responses were deemed valid and subsequently used for data analysis using the PLS-SEM approach with SmartPLS 4 software.

A summary of the sample characteristics is presented in Table 1, which presents the characteristics of the 248 valid firms. Medium-sized enterprises account for the largest proportion of the sample at 48.4 percent, followed by small-sized firms at 26.6 percent and large-sized firms at 25 percent. The sample covers various manufacturing sectors, with Electronics and Components representing the highest share at 20.6 percent, followed by Food and Beverage and Mechanical Engineering. Most firms have been operating for more than four years, with 38.3 percent in operation for 4 to 10 years and 30.6 percent for 11 to 20 years.

Table 1: Description of Sample (N = 248)

Characteristics	**Frequency**	**Percentage (%)**
Company size		
Small-sized	66	26.6
Medium-sized	120	48.4
Large-sized	62	25
Field of Activity		
Food and Beverage	40	16.1
Textiles, Apparel and Footwear	32	12.9
Electronics and Components	51	20.6
Mechanical Engineering and Machinery Manufacturing	40	16.1
Chemicals and Materials	30	12.1
Wood and Furniture	24	9.7
Construction and Building Materials	18	7.3
Others	13	9.4
Number of years in operation		
≤ 3 years	21	8.4
4 – 10 years	95	38.3
11 – 20 years	76	30.6
21 – 30 years	35	14.11
≥ 31 years	22	8.8

Scales Development

Using a quantitative approach, we fully adopted measurement scales from prior studies. Minor adjustments were made based on expert feedback to fit the Vietnamese context. The original scales, designed in English, were translated into Vietnamese by two independent language experts. The two translated versions were then compared to ensure consistency. Specifically, the "Process and Equipment" scale includes 5 items (20). The "Planning and Control" scale includes 5 items (20, 40). The "Human Resource Management" scale includes 6 items (40). The "Visual Information System" scale includes 5 items (52). The "Product Design" scale includes 5 items (20). The "Supplier Relationship" scale includes 7 items adopted from (11, 20). The "Customer Relationship" scale includes 6 items (11, 20). The "Competitive Advantages" scale includes 6 items (49). The "Firm Performance" scale includes 6 items (53).

All scales were measured using a 5-point Likert scale ranging from strongly disagrees to strongly agree. Before conducting the large-scale survey, a pilot test was carried out with a small group of respondents to assess readability. The results indicated that participants had no difficulty understanding or responding to the questionnaire.

Results

Reliability and Convergent Validity

The outer loadings should be ≥ 0.70, Cronbach's Alpha ≥ 0.70, Composite Reliability (CR) ≥ 0.70 and Average Variance Extracted (AVE) ≥ 0.50 to ensure the reliability and convergent validity of the measurement model. The results in the Table 2 show that all constructs satisfy these criteria. Specifically, all outer loadings exceed 0.70, Cronbach's Alpha ranges from 0.867 to 0.920, CR from 0.872 to 0.963 and AVE from 0.602 to 0.744. These results confirm that all observed items appropriately represent their latent constructs, the scales demonstrate high internal consistency and convergent validity and are therefore suitable for subsequent structural analyses.

Table 2: Reliability and Convergent Validity

Variables	Items	Outer loadings	Cronbach's Alpha	CR	AVE
CA	CA1	0.838	0.895	0.900	0.659
	CA2	0.877			
	CA3	0.880			
	CA4	0.741			
	CA5	0.763			
	CA6	0.757			
HR	HR1	0.797	0.867	0.872	0.602
	HR2	0.742			
	HR3	0.710			
	HR4	0.808			
	HR5	0.740			
	HR6	0.850			
FP	FP1	0.823	0.889	0.894	0.645
	FP2	0.831			
	FP3	0.817			
	FP4	0.879			
	FP5	0.718			
	FP6	0.740			
CR	CR1	0.811	0.920	0.957	0.696
	CR2	0.839			
	CR3	0.806			
	CR4	0.823			
	CR5	0.876			
	CR6	0.851			
PC	PC1	0.829	0.914	0.917	0.744
	PC2	0.934			
	PC3	0.864			
	PC4	0.855			

	PC5	0.827			
	PD1	0.755	0.905	0.914	0.727
	PD2	0.830			
PD	PD3	0.932			
	PD4	0.852			
	PD5	0.884			
	PE1	0.755	0.879	0.881	0.676
	PE2	0.848			
PE	PE3	0.899			
	PE4	0.808			
	PE5	0.793			
	SR1	0.793	0.896	0.904	0.619
	SR2	0.720			
	SR3	0.713			
SR	SR4	0.758			
	SR5	0.903			
	SR6	0.804			
	SR7	0.800			
	VIS1	0.754	0.874	0.963	0.645
	VIS2	0.880			
VIS	VIS3	0.878			
	VIS4	0.741			
	VIS5	0.750			

Discriminant Validity

The condition for establishing discriminant validity is that the square root of the AVE for each construct (the values on the diagonal) must be greater than the correlations between that construct and all other constructs (54). The results from the Table 3 show that all square roots of AVE (ranging from 0.776 to 0.863) are greater than the corresponding inter-construct correlations in the same rows and columns. This indicates that each latent construct is clearly distinguished from the others in the model.

Table 3: Discriminant Validity

	CA	HR	FP	CR	PC	PD	PE	SR	VIS
CA	0.811								
HR	0.490	0.776							
FP	0.678	0.688	0.803						
CR	-0.064	-0.042	-0.051	0.834					
PC	0.436	0.286	0.539	-0.025	0.863				
PD	0.628	0.462	0.627	-0.062	0.384	0.853			
PE	0.474	0.374	0.538	-0.116	0.290	0.431	0.822		
SR	0.635	0.508	0.664	-0.032	0.347	0.612	0.423	0.787	
VIS	-0.079	-0.008	-0.059	0.440	0.020	-0.069	-0.132	-0.082	0.803

Note: The diagonal values represent the square root of the Average Variance Extracted (AVE), while the off-diagonal elements indicate inter-construct correlations.

Quality Criteria Assessment

The R-square values from Table 4 indicate that the model explains 55.1 percent of the variance in Competitive Advantage and 73.5 percent of the variance in Firm Performance. The adjusted R-square values of 0.538 for Competitive Advantage and 0.726 for Firm Performance are very close to the original R-square values, suggesting strong explanatory power and minimal model overfitting.

Table 4: R-square and R-square Adjusted Assessment

	R-square	R-square adjusted
CA	0.551	0.538
FP	0.735	0.726

The Variance Inflation Factor values range from 1.231 to 2.229. All VIF values are well below the commonly accepted threshold of 5 and also below the more conservative threshold of 3.3, indicating that multicollinearity is not a concern in the model. These results from Table 5 suggest that the independent constructs are sufficiently distinct and do not exhibit problematic collinearity.

Table 5: VIF Assessment

	CA	CR	FP	HR	PC	PD	PE	SR	VIS
CA			2.229						
CR	1.468		1.499						
FP									
HR	1.251		1.251						
PC	1.231		1.285						
PD	1.818		1.984						
PE	1.365		1.409						
SR	1.861		2.055						
VIS	1.266		1.267						

Note: VIF = Variance Inflation Factor. Values represent the collinearity statistics of predictor constructs in the structural model.

Error! Not a valid bookmark self-reference. presents the model fit results. The SRMR value is 0.058 for both the saturated and estimated models, which is below the recom-mended threshold of 0.08, indicating a good model fit. The NFI value is 0.748, suggesting an acceptable but moderate level of model fit, while it does not exceed the conventional benchmark of 0.90.

Table 6*:* Model Fit Indices for the Saturated Model

	Saturated Model	Estimated Model
SRMR	0.058	0.058
d_ULS	4.386	4.386
d_G	2.015	2.015
Chi-square	2574.350	2574.350
NFI	0.748	0.748

Direction Relationship Testing

In this section, the authors test the direct impact of lean manufacturing practices on the firm performance. The relationship in the structural model is considered significant when the p-value is less than 0.05 (55). The path coefficient (β) indicates the direction and strength of the relationship, while f^2 represents the effect size, with thresholds of 0.02, 0.15 and 0.35 corresponding to small, medium and large effects, respectively (56). The results from Table 7 indicate that six hypotheses are significant: H1 (PE → FP, β = 0.145, t = 3.107, p = 0.002, f^2 = 0.056), H2 (PC → FP, β = 0.226, t = 5.257, p = 0.000, f^2 = 0.149), H3 (HR → FP, β = 0.353, t = 5.619, p = 0.000, f^2 = 0.313), H5 (PD → FP, β = 0.106, t = 2.493, p = 0.013, f^2 = 0.022), H6 (SR → FP, β = 0.179, t = 3.519, p = 0.000, f^2 = 0.059) and H8 (CA → FP, β = 0.158, t = 2.993, p = 0.003, f^2 = 0.042).

In contrast, H4 (VIS → FP, β = –0.013, t = 0.315, p = 0.753, f^2 = 0.009) and H7 (CR → FP, β = 0.015, t = 0.317, p = 0.551, f^2 = 0.011) are not significant. These findings demonstrate that most Lean Manufacturing practices including process and equipment, planning and control, human resource management, product design, supplier relation-ship and competitive advantages have a positive and significant influence on firm performance, while visual information system and customer relationship show the contrast status.

Table 7: Direction Relationship Testing

Hypotheses	Path	β	t- statistics	p-values	f²	Decisions
H1	PE → FP	0.145	3.107	0.002	0.056	Accepted
H2	PC → FP	0.226	5.257	0.000	0.149	Accepted
H3	HR → FP	0.353	5.619	0.000	0.313	Accepted
H4	VIS → FP	-0.013	0.315	0.753	0.009	Rejected
H5	PD → FP	0.106	2.493	0.013	0.022	Accepted

H6	SR → FP	0.179	3.519	0.000	0.059	Accepted
H7	CR → FP	0.015	0.317	0.551	0.011	Rejected
H8	CA → FP	0.158	2.993	0.003	0.042	Accepted

Indirection Relationship Testing

In this section, the authors test the mediating role of competitive advantages in the link between lean manufacturing practices and firm performance. The analysis follows the mediation testing approach (57), in which a mediating effect is confirmed when the indirect effect is statistically significant ($p < 0.05$), indicating that the mediator transmits the influence between the independent and dependent variables.

By bootstrapping technical with 1,000 sample, the results from Table 8 show that competitive advantage (CA) serves as a partial mediator in four relationships: planning and control (PC → CA → FP, β = 0.025, t = 2.230, p = 0.026), product design (PD → CA → FP, β = 0.043, t = 2.415, p = 0.016), process and equipment (PE → CA → FP, β = 0.022, t = 2.010, p = 0.044) and supplier relationship (SR → CA → FP, β = 0.047, t = 2.430, p = 0.015). In contrast, the indirect effects of human resource management (HR → CA → FP, p = 0.083), customer relationship (CR → CA → FP, p = 0.937) and visual information system (VIS → CA → FP, p = 0.773) are not significant.

Table 8: Indirection Relationship Testing

Path	β	t statistics	p values	Decisions
HR → CA → FP	0.019	1.735	0.083	Rejected
CR → CA → FP	-0.001	0.080	0.937	Rejected
PC → CA → FP	0.025	2.230	0.026	Accepted
PD → CA → FP	0.043	2.415	0.016	Accepted
PE → CA → FP	0.022	2.010	0.044	Accepted
SR → CA → FP	0.047	2.430	0.015	Accepted
VIS → CA → FP	-0.003	0.288	0.773	Rejected

Discussion

The empirical results show that five out of seven Lean Manufacturing (LM) dimensions including Process and Equipment (PE), Planning and Control (PC), Human Resource Management (HR), Product Design (PD) and Supplier Relationship (SR) have a positive and direct effect on firm performance (FP). This finding indicates that lean practices improve firm performance by eliminating non-value-adding activities and promoting the integrated management of production processes, workforce relationships and supplier collaboration. These results are consistent with previous studies on Lean, where many scholars argued that process improvement and resource optimization help eliminate waste, improve quality and flexibility and enhance overall performance (5, 24).

First, Process and Equipment (PE) has a significant positive impact on FP, supporting H1 with β = 0.145, t = 3.107, p = 0.002, f^2 = 0.056. This suggests that manufacturing firms in Northern Vietnam place strong emphasis on improving production machinery and process quality. Their production processes are well-managed and systematically designed to minimize product defects, while error-handling procedures are implemented meticulously. This approach reduces product loss during production, saving time, costs and input materials, which contributes to long-term performance improvement. This finding aligns with prior studies emphasizing that firms should focus on high-quality equipment and optimized processes to prevent breakdowns, leakages and excessive energy consumption (58, 59).

Second, Planning and Control (PC) practices in lean manufacturing, such as leveled production and pull systems (Kanban) have been shown to reduce inventory and waste while ensuring timely delivery. Therefore, enhancing operational efficiency compared to traditional production methods, supporting H2 with β = 0.226, t = 5.257, p = 0.000, f^2 = 0.149. Empirical evidence from this study reveals that firms plan production batches carefully through structured documentation and managerial oversight. The implementation of pull-based control systems helps reduce post-production inventory and damaged goods. Contrary to previous findings, our study

demonstrates that, in the context of Vietnamese manufacturing firms, PC positively influences FP (5, 20). This reinforces the managerial importance of thoroughly designing production planning and control mechanisms before execution.

Third, the Human Resource Management (HRM) factor proved to be the most influential among all lean dimensions, demonstrating its critical role in enhancing firm performance (FP), supporting H3 with β = 0.353, t = 5.619, p = 0.000. This result contrasts with previous findings, which found no significant relationship between HRM and FP (20), thus emphasizing the strategic importance of human factors in the Vietnamese context. Employees directly operate and manage machinery (60), so lean systems cannot function effectively without an organizational culture that promotes learning, sharing and continuous improvement. Lean HRM practices such as training, empowerment, recognition and innovation incentives enable employees to actively participate in improvement processes, fostering stronger commitment and productivity (23). Moreover, an effective HRM system acts as a bridge between management levels, facilitating the diffusion of lean thinking and ensuring long-term sustainability of improvement outcomes. In Vietnam's ongoing transition toward lean manufacturing, workforce competence, work attitude and proactive learning play a strategic role in determining the firm's ability to absorb and implement lean tools such as 5S, Kaizen and TPM.

Fourth, although this factor is newly introduced in comparison with previous studies (5, 20). The Visual Information System (VIS) does not show a statistically significant direct impact on firm performance, not supporting H4 with β = –0.013, t = 0.315, p = 0.753, f^2 = 0.009. While lean theory suggests that visual information systems (e.g., signboards, charts, signal cards) enhance process transparency, allowing for faster detection of deviations and timely decision-making (10), this study finds no empirical evidence that VIS directly improves overall performance. A plausible explanation is that VIS mainly plays a supportive or indirect role and must be integrated with other lean practices to create a measurable effect. When considered in isolation, the contribution of VIS to financial or operational outcomes may be too small to detect statistically. The inclusion of VIS as an independent variable for the first time in this model offers a novel insight: not all lean practices necessarily generate tangible performance benefits. This result contributes to the existing research gap and highlights the need for further investigation into the role of VIS across different contexts to better understand the conditions and mechanisms through which visual systems influence firm performance.

Fifth, Product Design (PD) shows a positive and statistically significant effect on firm performance, supporting H5 with β = 0.106, t = 2.493, p = 0.013, f^2 = 0.022. PD emphasizes the design stage, which is a critical starting point determining the overall leanness of the production process. Careful design that anticipates risks and production factors from the outset helps reduce waste in time, materials and costs resulting from later rework or design changes. This finding aligns with some studies, which asserted that lean-oriented product design bridges engineering and production, shortens product development cycles and enhances responsiveness to customer needs (38)

Sixth, the results show that Supplier Relationship (SR) has a positive and statistically significant effect on firm performance, supporting H6 with β = 0.179, t = 3.519, p = 0.000, f^2 = 0.059. This finding is consistent with several previous studies, which identified supplier collaboration as a key driver of both environmental and operational performance (20). Lean supply chain management practices help eliminate waste arising from excess capacity and inventory by reducing variability in supply (60). When firms closely collaborate with suppliers from the early stages of product design, process quality improves and waste is significantly minimized (60).

Similarly, the findings regarding Customer Relationship (CR) indicate that although maintaining strong customer relationships is widely recognized as essential for a firm's long-term success. It does not directly lead to significant improvements in performance in this context, not supporting H7 with β = 0.015, t = 0.317, p = 0.551, f^2 = 0.011. Our result partly contrasts with the previous suggestion. This argues that a strategic customer service orientation can enhance both operational and business performance when effectively integrated with lean practices (46). Some studies have also suggested that firms emphasizing customer focus often implement both technical and human-

oriented lean practices simultaneously, which together generate superior results (20). However, our findings reveal that managing customer relationships alone may not be sufficient to improve performance without complementary internal improvements. In other words, the benefits gained from customer interactions such as quicker responses to needs and higher satisfaction may already be absorbed into improvements in product or service quality, thereby contributing little additional effect to overall firm performance. One of the main contributions of this study is the examination of the mediating role of competitive advantage (CA), supporting H8 with β = 0.158, t = 2.993, p = 0.003, f^2 = 0.042. Empirical evidence shows that CA partially mediates four relationships between Lean Manufacturing (LM) dimensions and firm performance: Process and Equipment (β = 0.022, t = 2.010, p = 0.044), Planning and Control (β = 0.025, t = 2.230, p = 0.026), Product Design (β = 0.043, t = 2.415, p = 0.016) and Supplier Relationship (β = 0.047, t = 2.430, p = 0.015). This finding fills a gap in previous research, which primarily focused on mediating mechanisms such as supply chain management, lean culture and management accounting. The results suggest a mechanism in which Lean first enhances firms' internal operational capabilities through waste elimination, process optimization and quality improvement, thereby creating sustainable competitive advantages such as lower costs, superior quality and greater flexibility. These competitive advantages, in turn, serve as key drivers of firm performance. This approach extends the theoretical perspective on Lean Manufacturing by emphasizing the bridging role of competitive advantage in transforming operational improvements into strategic advantages that enhance firm performance. In the case of Human Resource Management, it is found that it has a significant effect on the firm despite being a direct factor, while it is not supported as an indirect factor through competitive advantage (p = 0.083). This shows that HRM affects firm performance through its internal mechanisms of operation. These mechanisms include productivity, employee engagement and efficiency. However, it is found that these factors do not necessarily mean having a special position in the competitive arena.

Similarly, the effect of Customer Relationship is not very high with regard to indirect effects through competitiveness (p = 0.937). The implementation of customer-oriented practices can have a direct effect on customer satisfaction and loyalty. However, these factors might not have a significant impact on converting them into tangible benefits such as cost, quality and delivery; hence, the effect can be operational and not at a strategic level for competitiveness. Related to Visual Information System, once again, there is no support for a mediating effect (p = 0.773). The main role of visual management tools may be as supporting means in lean implementation. Their role is to improve transparency and enable better communication. Without strong linkage with basic lean tools, it may be seen that their impact would be insufficient.

Conclusion

Our study provides the first empirical evidence on Lean Manufacturing (LM) practices among manufacturing enterprises in Northern Vietnam. The results show that five practices, including Process and Equipment (PE), Planning and Control (PC), Human Resource Management (HR), Product Design (PD) and Supplier Relationship (SR), have positive effects on firm performance, while Visual Information System (VIS) and Customer Relationship (CR) do not show significant impacts. A key contribution of this research is the examination of the mediating role of competitive advantage (CA) between Lean practices and firm performance. The findings reveal that CA not only has a direct positive influence on performance but also partially mediates the relationships between PE, PC, PD and SR with firm performance. This indicates that Lean helps firms first improve their operational efficiency, which is then transformed into competitive advantages that enhance overall business performance.

Theoretical Implications

From a theoretical perspective, this study provides several important contributions. First, the results demonstrate that Lean Manufacturing enhances firm performance through the creation of competitive advantage, thereby reinforcing the Dynamic Capability Theory (DCT) by showing that improvements derived from Lean are transformed into internal capabilities that

generate sustainable competitive advantage. Second, the study extends the application of DCT to the context of manufacturing firms in Vietnam, adding empirical evidence in a setting where Lean implementation remains limited. This confirms the applicability of DCT within an emerging economy and fills an existing gap in Lean research in Vietnam. Finally, by measuring each Lean practice separately rather than aggregating them; the study clarifies the specific mechanisms through which each Lean dimension influences competitive advantage and performance, contributing to the refinement of Lean theory by revealing that not all Lean aspects exert equal effects.

Practical Implications

First, Lean Manufacturing only brings sustainable results when improvements such as waste reduction, quality enhancement and increased speed are transformed into superior competitive advantages (CA). If a firm can establish clear advantages in cost, quality and speed compared to its competitors, its performance will improve sustainably. Therefore, Lean should be implemented with the strategic goal of building CA, viewing it as the bridge that converts internal improvements into long-term business success.

Second, five core Lean practices (PE, PC, HR, PD, SR) have been shown to have a direct positive impact on firm performance. Firms should prioritize their resources toward these aspects rather than spreading them too thin. In contrast, in the Vietnamese context, VIS (Visual Information System) and CR (Customer Relationship) have not shown significant performance improvement. Manufacturing firms in Northern Vietnam should therefore pay more attention to these two areas to enhance both Lean implementation effectiveness and overall performance.

Third, firms should implement Lean progressively in three stages. The first (internal) stage focuses on process stability, equipment optimization and workforce development (PE, PC, HR). The second (external) stage streamlines product design and strengthens supplier collaboration (PD, SR) to meet market demand more effectively. The third (supporting) stage applies VIS and CR tools to increase information transparency and engage customers in the improvement process.

Fourth, firms should build a KPI system aligned with the Lean-to CA to FP chain to monitor improvement progress. This KPI set should range from Lean implementation indicators such as improvement projects and waste reduction to competitive advantage indicators related to cost, quality and speed, as well as financial performance results. Using tools like OKR or Hoshin Kanri can help connect Lean objectives with competitive and financial goals. Such a monitoring system enables managers to verify how operational improvements translate into competitive and financial outcomes and make timely adjustments when needed.

Finally, for Vietnamese firms with limited resources and Lean experience, implementation should begin cautiously and gradually instead of all at once. Managers should start with small pilot projects supported by a tracking system to measure outcomes and gain experience before expanding. Early successes will help build organizational confidence and create a foundation for wider Lean adoption. In contrast, large-scale implementation without proper measurement may obscure results and cause firms to miss opportunities for long-term performance improvement.

Limitations and Further Research

Despite its contributions, this study has several limitations that should be acknowledged to enhance the credibility and interpretation of the findings. First, the data were collected using a cross-sectional survey design, which limits the ability to establish causal relationships among lean manufacturing practices, competitive advantage and firm performance. Future studies may employ longitudinal designs to better capture dynamic changes and causality over time. Second, the study relies on self-reported data from single respondents within each firm, which may introduce common method bias and subjective perception bias. Although procedural remedies such as respondent screening and confidentiality assurances were applied, future research could strengthen robustness by using multi-respondent data or incorporating objective performance indicators. Third, the sample was restricted to manufacturing firms located in the Northern region of Vietnam. While this region represents a major industrial hub, the findings may not be fully generalizable to firms operating

in other regions or countries with different institutional, cultural and market conditions. Expanding the geographical scope would enhance external validity. Fourth, lean manufacturing was examined through selected dimensions based on prior studies. Although these dimensions capture key aspects of lean implementation, other contextual or emerging practices, such as digital lean tools or Industry 4.0 integration, were not considered. Including such factors may provide a more comprehensive understanding of lean effectiveness.

Abbreviations

ISO: International Organization for Standardization, PLS-SEM: Partial Least Squares Structural Equation Modelling.

Acknowledgement

The authors express appreciation to the participating manufacturing firms in Northern Vietnam for their collaboration and support throughout the data collection process. The authors also acknowledge the constructive feedback provided by colleagues during the development of this research.

Author Contributions

Hoang Thi Huong: conceptualization, research design, data analysis, data collection, manuscript drafting, Nguyen Thi Trang Nhung: data collection, questionnaire development, preliminary data processing, Nguyen Thi Van Anh: literature review, hypothesis development, interpretation of results, Hoang Van Hoanh: data validation, visualization, revision of empirical results, Nguyen Duy Chuc: data collection coordination, manuscript editing, Le Thi Hai: critical revision of the manuscript, overall academic supervision. All authors read, revised and approved the final version of the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest related to the publication of this manuscript.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declaration of Artificial Intelligence (AI) Assistance

Generative AI and AI-assisted technologies were employed to enhance the clarity, grammar and readability of the manuscript. The authors carefully reviewed, edited and verified all content generated with these tools and they take full academic responsibility for the integrity and originality of the work.

Ethics Approval

The study followed ethical research standards and participation by firms was voluntary. All respondents were informed about the purpose of the research and confidentiality was ensured.

Funding

This research is funded by Hanoi University of Industry under Contract No. 68-2025-RD/HD-ĐHCN.

References

1. Kawai M, Wignaraja G. Asian FTAs: Trends, prospects and challenges. Journal of Asian Economics. 2011;22(1):1-22. https://doi.org/10.1016/j.asieco.2010.10.002
2. Zhang Y. The impact of free trade agreements on business activity: A survey of firms in the People's Republic of China. ADBI Working Paper; 2010. https://www.econstor.eu/handle/10419/53628
3. Matsushita M. Interplay of Competition Law and Free Trade Agreements in Regulating State-Owned Enterprises. German Law Journal. 2023;24(1):243-68. https://doi.org/10.1017/glj.2023.8
4. Bashith A, Nasith A, Saifullah S, Amin S, Purwono BSA. Entrepreneurial innovation strategy to Asean economic community and China-Asean free trade agreement. Journal of Advanced Research in Dynamical and Control Systems. 2019;11(11):150-6. https://repository.uin-malang.ac.id/5104/
5. Iranmanesh M, Zailani S, Hyun SS, Ali MH, Kim K. Impact of lean manufacturing practices on firms' sustainable performance: Lean culture as a moderator. Sustainability. 2019;11(4):1112. https://doi.org/10.3390/su11041112
6. Kariuki BM, Mburu DK. Role of Lean manufacturing on organization competitiveness. Industrial Engineering Letters. 2013;3(10):81-2. https://www.iiste.org/Journals/index.php/IEL/article/view/8012
7. Minh DH, Phuong PTT. The relationship between organizational culture and lean manufacturing in manufacturing SMEs in Vietnam: Exploring the moderating role of sustainable leadership. Journal of the International Council for Small Business. 2025:1-20. https://doi.org/10.1080/26437015.2025.2568923
8. Pettersen J. Defining lean production: some conceptual and practical issues. The TQM journal.

2009;21(2):127-42. https://doi.org/10.1108/17542730910938137
9. Huo B, Gu M, Wang Z. Green or lean? A supply chain approach to sustainable performance. Journal of cleaner production. 2019;216:152-66. https://doi.org/10.1016/j.jclepro.2019.01.141
10. Wahab ANA, Mukhtar M, Sulaiman R. A conceptual model of lean manufacturing dimensions. Procedia Technology. 2013;11:1292-8. https://doi.org/10.1016/j.protcy.2013.12.327
11. Dieste M, Panizzolo R, Garza-Reyes JA. A systematic literature review regarding the influence of lean manufacturing on firms' financial performance. Journal of Manufacturing Technology Management. 2021;32(9):101-21. https://doi.org/10.1108/JMTM-08-2020-0304
12. Wang CL, Senaratne C, Rafiq M. Success traps, dynamic capabilities and firm performance. British Journal of Management. 2015;26(1):26-44. https://doi.org/10.1111/1467-8551.12066
13. Huff A, Floyd S, Sherman H. Strategic Management: Logic and Action John Wiley Sons. New York. 2009. https://www.scirp.org/reference/referencespapers?referenceid=2265132
14. Ma H. Competitive advantage and firm performance. Competitiveness Review: An International Business Journal. 2000;10(2):15-32. https://doi.org/10.1108/eb046396
15. Mohaghegh M, Blasi S, Groessler A. Dynamic capabilities linking lean practices and sustainable business performance. Journal of Cleaner Production. 2021;322:129073. https://doi.org/10.1016/j.jclepro.2021.129073
16. Saini S, Singh D. Impact of implementing lean practices on firm performance: a study of Northern India SMEs. International Journal of Lean Six Sigma. 2020;11(6):1005-34. https://doi.org/10.1108/IJLSS-06-2019-0069
17. Zhu X, Lin Y. Does lean manufacturing improve firm value? Journal of Manufacturing Technology Management. 2017;28(4):422-37. https://doi.org/10.1108/JMTM-05-2016-0071
18. Duc NT, Quoc CN. Exploring critical factors for successfully implementing lean manufacturing at manufacturiing companies in Vietnam. International Journal for Quality Research. 2017; 11(2). https://www.ijqr.net/journal/v11-n2/12.pdf
19. Nguyen DM, Duong TK. Enterprises characteristics and lean outcome: an empirical evidence from Vietnam manufacturing enterprises. Management Systems in Production Engineering. 2022;30(2):98-108. https://doi.org/10.2478/mspe-2022-0013
20. Awan FH, Dunnan L, Jamil K, *et al.* Mediating role of green supply chain management between lean manufacturing practices and sustainable performance. Frontiers in psychology. 2022;12:810504. https://doi.org/10.3389/fpsyg.2021.810504
21. Ali MA. The influence of lean manufacturing on firm performance through mediation of supply chain practices. South Asian Journal of operations and Logistics. 2024;3(1):39-53. https://doi.org/10.57044/SAJOL.2024.3.1.2424
22. Fullerton RR, Kennedy FA, Widener SK. Lean manufacturing and firm performance: The incremental contribution of lean management accounting practices. Journal of Operations Management. 2014;32(7-8):414-28. https://doi.org/10.1016/j.jom.2014.09.002
23. Aripin N, Nawanir G, Hussain S. Lean culture for a successful lean manufacturing implementation: an empirical evidence from Malaysian manufacturing industry. International Journal of Industrial Management. 2023;17(2):76-83. https://journal.ump.edu.my/ijim/article/view/9037
24. Yang MGM, Hong P, Modi SB. Impact of lean manufacturing and environmental management on business performance: An empirical study of manufacturing firms. International Journal of production economics. 2011;129(2):251-61. https://doi.org/10.1016/j.ijpe.2010.10.017
25. Kovach J, Stringfellow P, Turner J, Cho BR. The house of competitiveness: The marriage of agile manufacturing, design for Six Sigma and lean manufacturing with quality considerations. Journal of Industrial Technology. 2005;21(3). https://www.iastatedigitalpress.com/jtmae/article/id/14233/
26. Verma N, Sharma V. Sustainable competitive advantage by implementing lean manufacturing "A Case study for Indian SME". Materials Today: Proceedings. 2017;4(8):9210-7. https://doi.org/10.1016/j.matpr.2017.07.279
27. Ghaithan AM, Alshammakhi Y, Mohammed A, Mazher KM. Integrated impact of circular economy, industry 4.0 and lean manufacturing on sustainability performance of manufacturing firms. International Journal of Environmental Research and Public Health. 2023;20(6):5119. https://doi.org/10.3390/ijerph20065119
28. Kamble S, Gunasekaran A, Dhone NC. Industry 4.0 and lean manufacturing practices for sustainable organisational performance in Indian manufacturing companies. International journal of production research. 2020;58(5):1319-37. https://doi.org/10.1080/00207543.2019.1630772
29. Burawat P. The relationships among transformational leadership, sustainable leadership, lean manufacturing and sustainability performance in Thai SMEs manufacturing industry. International Journal of Quality & Reliability Management. 2019;36(6):1014-36. https://doi.org/10.1108/IJQRM-09-2017-0178
30. Teece DJ, Pisano G, Shuen A.Dynamic capabilities and strategic management. Strategic Management Journal, 1997; 18(7): 509-533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7%3C509::AID-SMJ882%3E3.0.CO;2-Z
31. Rothenberg S, Pil FK, Maxwell J. Lean, green and the quest for superior environmental performance. Production and operations management. 2001;10(3):228-43. https://doi.org/10.1111/j.1937-5956.2001.tb00372.x
32. Vinodh S, Arvind K, Somanaathan M. Tools and techniques for enabling sustainability through lean initiatives. Clean technologies and environmental policy. 2011;13(3):469-79. https://doi.org/10.1007/s10098-010-0329-x

33. Florida R. Lean and green: the move to environmentally conscious manufacturing. California management review.1996;39(1):80-105. https://doi.org/10.2307/41165877
34. King AA, Lenox MJ. Lean and green? An empirical examination of the relationship between lean production and environmental performance. Production and operations management. 2001;10(3): 244-56. https://doi.org/10.1111/j.1937-5956.2001.tb00373.x
35. Eaidgah Y, Maki AA, Kurczewski K, Abdekhodaee A. Visual management, performance management and continuous improvement: A lean manufacturing approach. International Journal of Lean Six Sigma. 2016;7(2):187-210. https://doi.org/10.1108/IJLSS-09-2014-0028
36. Lindskog E, Vallhagen J, Berglund J, Johansson B. Improving lean design of production systems by visualization support. Procedia Cirp. 2016;41:602-7. https://doi.org/10.1016/j.procir.2016.01.004
37. Dahmani N, Belhadi A, Benhida K, Elfezazi S, Touriki FE, Azougagh Y. Integrating lean design and eco-design to improve product design: From literature review to an operational framework. Energy & Environment. 2022;33(1):189-219. https://doi.org/10.1177/0958305X21993481
38. Jayaram J, Vickery S, Droge C. Relationship building, lean strategy and firm performance: an exploratory study in the automotive supplier industry. International Journal of Production Research. 2008;46(20): 5633-49. https://doi.org/10.1080/00207540701429942
39. Huang Z, Jowers C, Kent D, Dehghan-Manshadi A, Dargusch MS. The implementation of Industry 4.0 in manufacturing: from lean manufacturing to product design. The International Journal of Advanced Manufacturing Technology. 2022;121(5):3351-67. https://doi.org/10.1007/s00170-022-09511-7
40. Panizzolo R. Applying the lessons learned from 27 lean manufacturers.: The relevance of relationships management. International journal of production economics. 1998;55(3):223-40. https://doi.org/10.1016/S0925-5273(98)00066-8
41. Ahmad S, Schroeder RG, Sinha KK. The role of infrastructure practices in the effectiveness of JIT practices: implications for plant competitiveness. Journal of Engineering and Technology management. 2003;20(3):161-91. https://doi.org/10.1016/S0923-4748(03)00017-1
42. Do QH. Critical factors affecting the choice of logistics service provider: An empirical study in Vietnam. The Journal of Asian Finance, Economics and Business. 2021;8(4):145-50. https://doi.org/10.13106/jafeb.2021.vol8.no4.0145
43. Tran, Pham, Nguyen. Digital transformation solution implementation risk in logistics and supply chain industry. Discover Sustainability. 2026. https://doi.org/10.1007/s43621-026-02603-4
44. Harryani S. Customer relationship management influence on customer value, product quality and service quality in improving customer satisfaction and its implication on the customer loyalty. Jurnal Ilmiah Ekonomi Bisnis. 2017;22(2). https://www.neliti.com/publications/178575/customer-relationship-management-influence-on-customer-value-product-quality-and
45. Yan J, Zheng Y, Bao J, *et al*. How to improve new product performance through customer relationship management and product development management: evidence from China. Journal of Business & Industrial Marketing. 2021;36(1):31-47. https://doi.org/10.1108/JBIM-05-2019-0190
46. Hong P, Ga Yang M, D. Dobrzykowski D. Strategic customer service orientation, lean manufacturing practices and performance outcomes: an empirical study. Journal of Service Management. 2014;25(5): 699-723. https://doi.org/10.1108/JOSM-12-2013-0355
47. Prado-Prado JC, García-Arca J, Fernández-González AJ, Mosteiro-Añón M. Increasing competitiveness through the implementation of lean management in healthcare. International Journal of Environmental Research and Public Health. 2020;17(14):4981. https://doi.org/10.3390/ijerph17144981
48. Teece DJ. Business models and dynamic capabilities. Long range planning. 2018;51(1):40-9. https://doi.org/10.1016/j.lrp.2017.06.007
49. Novitasari M, Agustia D. Competitive advantage as a mediating effect in the impact of green innovation and firm performance. Business: Theory and Practice. 2023;24(1):216-26. https://doi.org/10.3846/btp.2023.15865
50. Nuseir MT, Refae GAE, Aljumah A. The lean management practices impact on the competitive advantage and business performance. International Journal of Economics and Business Research. 2024;28(6):1-20. https://doi.org/10.1504/IJEBR.2024.10066714
51. Tupamahu KH, Ghozali I, Basuki P. Lean management, competitive advantage and firm performance: the role of management control systems (evidence from Indonesia manufacturing firms). Academic Journal of Interdisciplinary Studies. 2019;8(3):221-33. https://doi.org/10.36941/ajis-2019-0020
52. Karlsson C, Åhlström P. Assessing changes towards lean production. International Journal of Operations & Production Management. 1996;16(2):24-41. https://doi.org/10.1108/01443579610109820
53. Le TT. Corporate social responsibility and SMEs' performance: mediating role of corporate image, corporate reputation and customer loyalty. International Journal of Emerging Markets. 2023; 18(10):4565-90. https://doi.org/10.1108/IJOEM-07-2021-1164
54. Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. Journal of marketing research. 1981;18(1):39-50. http://www.jstor.org/stable/3151312
55. Hair JF, Black WC, Babin BJ anderson RE, Tatham RL. Multivariate data analysis (6th Edition), Upper Saddle River, NJ: Pearson Prentice Hall. 2006. https://www.scirp.org/reference/ReferencesPapers?ReferenceID=1385913
56. Cohen SA. Understanding the sustainable lifestyle. The European Financial Review. 2017;1(1):7-9. https://www.researchgate.net/publication/325273718_Understanding_the_Sustainable_Lifestyle

57. Hair JF, Risher JJ, Sarstedt M, Ringle CM. When to use and how to report the results of PLS-SEM. European business review. 2019;31(1):2-24. https://doi.org/10.1108/EBR-11-2018-0203
58. Tripathi V, Chattopadhyaya S, Mukhopadhyay AK, *et al.* An innovative agile model of smart lean–green approach for sustainability enhancement in Industry 4.0. Journal of Open Innovation: Technology, Market and Complexity. 2021;7(4):215. https://doi.org/10.3390/joitmc7040215
59. Chavez R, Yu W, Jajja MSS, Song Y, Nakara W. The relationship between internal lean practices and sustainable performance: exploring the mediating role of social performance. Production Planning & Control. 2022;33(11):1025-42. https://doi.org/10.1080/09537287.2020.1839139
60. Vanichchinchai A. The effect of lean manufacturing on a supply chain relationship and performance. Sustainability. 2019;11(20):5751. https://doi.org/10.3390/su11205751

How to Cite: Huong HT, Nhung NTT, Anh NTV, Hoanh HV, Chuc ND, Hai LT. Does Lean Manufacturing Practices Improve Firm Performance: Mediating Role of Competitive Advantages? Int Res J Multidiscip Scope. 2026; 7(2): 1531-1547. DOI: 10.47857/irjms.2026.v07i02.09130