

An Empirical Investigation of Socially- And Technically- Oriented Lean Practices and Their Influence on Operational and Business Performance in Malaysian Manufacturing Firms

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Abstract

The study aims to empirically investigate the relationships among lean production practices, business performance, and operational performance within the Malaysian manufacturing firms. Anchored in Socio-Technical Systems Theory (STS) and Program Theory, the study develops and tests a conceptual framework that distinguishes between socially-oriented lean production (SLEAN) and technically-oriented lean production (TLEAN), examining their individual and combined effects on BP and OP outcomes. While existing theoretical frameworks suggest a positive relationship between lean practices and organizational performance, prior empirical findings have been mixed and, in some cases, inconclusive. Addressing this gap, the present study employs sample data of 205 manufacturing firms, selected randomly from the Federation of Malaysian Manufacturers Directory. Structural Equation Modeling (SEM) was conducted to analyze the data using the AMOS and SPSS software programs. The findings show that lean approaches that are both technically and socially oriented have significantly improved the OP. Furthermore, the OP is found to partially mediate the relationship between both dimensions of BP and lean production. A significant direct relationship is also observed between BP and OP. This study contributes to the operations management literature by providing empirical validation of the differentiated roles of social and technical lean practices in shaping firm-level performance. The findings offer both theoretical and practical implications, improving the academic discourse on lean production systems and offering actionable insights for managers seeking to implement and sustain lean initiatives to enhance organizational outcomes.

Keywords: *Lean Production Practices; Firm Performance; Program Theory; Malaysian Manufacturing Companies.*

Introduction

Since its emergence in the 1980s, lean production has garnered significant attention from both manufacturing practitioners and academic researchers (Monden, 1981; Womack, Jones, & Roos, 1990; Katayama & Bennett, 1996; Shah & Ward, 2003, 2007; Liker, 2004; Li et al., 2006; Matsui, 2007; Pham et al., 2008; Arawati & Rosman, 2013). Often regarded as a foundational management paradigm for the 21st century (Womack et al., 1990), lean production is premised on enhancing customer satisfaction while improving organizational efficiency and effectiveness (Ferdousi & Ahmed, 2009). Its principles have profoundly influenced modern operations and supply chain management by emphasizing continuous improvement (CI), waste reduction, and process optimization. Despite its widespread adoption, empirical research on lean production remains relatively underdeveloped. Several scholars have noted that lean research, particularly in operational contexts, is still in its formative stages (Ferdousi & Ahmed, 2009; Wong et al., 2009). In the Malaysian manufacturing context specifically, there is a noticeable paucity of empirical studies examining the implementation and outcomes of lean practices. To date, there is limited empirical evidence establishing clear linkages between lean

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production, business performance (BP) and operational performance (OP) in the Malaysian manufacturing firm context. This gap is further highlighted by previous research, which indicates that while theoretical frameworks suggest a positive relationship between lean practices and organizational outcomes, empirical findings are often inconclusive or context-dependent (Cua et al., 2001; Papadopoulou & Ozbayrak, 2005; Shah & Ward, 2003, 2007; Pettersen, 2009). Thus, a need exists for context-specific investigations that empirically test these assumed relationships. In response, the study aims to explore the relationship among lean production, OP and BP within the Malaysian manufacturing industry.

Literature Review

Liker (2004) describes lean production as a manufacturing philosophy aimed at minimizing lead time from customer order to delivery by systematically removing waste throughout the production process. Central to this philosophy is the notion that any expenditure of resources that does not contribute to value creation for the end customer constitutes waste. Expanding on this concept, Shah and Ward (2007) conceptualize lean production as an integrated socio-technical system designed to eliminate waste by concurrently minimizing variability across supplier, customer, and internal processes. They emphasize that lean must be understood not merely as a set of isolated tools or practices, but as a coherent configuration of interrelated components that must be implemented holistically to achieve meaningful performance improvements. In line with these perspectives, the present study defines lean production as comprehensive manufacturing strategies that integrates both technical (technology-driven) and social (human-centric) elements, with the fundamental goal of improving BP. This is achieved by continually improving OP through the systematic identification, reduction, and eventual removal of all forms of waste within production processes.

The matrix table illustrating the numerous lean production practices put forth by various researchers in previous literature is presented in Table 1. Following a comprehensive review of prior research on lean production, this study includes eight components that are often cited in the literature as being a part of lean production practices: (i) Supplier Focus (SF) and Employee Focus (EF), (ii) CI, (iv) Customer Focus (CF), (v) Quality At Source (QAS), (vi) Just-In-Time (JIT), (vii) Flow System (FS), and (viii) Technological & Innovation (TI).

Table 1: Lean Production Practices and Their Appearance in Key References

| Lean Practices | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|------------------------------|---|---|---|---|---|---|---|---|---|----|----|
| 1. Supplier focus | * | * | * | | * | * | * | * | * | * | * |
| 2. Employee focus | * | * | | * | * | | * | * | * | * | |
| 3. Continuous improvement | * | * | * | * | * | | * | * | * | * | * |
| 4. Customer focus | * | * | | | * | | * | | | * | * |
| 5. Quality at source | * | * | | | * | | * | | | * | * |
| 6. Just-in time | * | * | | | * | | * | * | * | * | |
| 7. Flow system | * | * | * | * | * | | * | | * | * | * |
| 8. Technology and innovation | | * | | | * | | * | | * | | * |

(1) Shahram (2008); (2) Shah and Ward (2007); (3) Bhasin and Burcher (2006); (4) Woorley and Doolen (2006); (5) Liker (2004); (6) Wu (2003); (7) Shah and Ward (2003); (8) Sanchez and Perez (2001); (9) Cua et al. (2001); (10) Karlsson and Ahlstrom (1996); (11) Katayama and Bennett (1996).

This study classifies lean production practices into two distinct categories based on STS: SLEAN and TLEAN. The SLEAN encompasses practices that emphasize human and relational aspects, including CF, SF, EF, and CI. Conversely, the TLEAN comprises practices centered on process and technological elements, specifically JIT, FS, QAS, and TI.

OP is defined as the extent to which a company's processes are executed in alignment with established operational standards (Cua et al., 2001; Shah & Ward, 2003, 2007). In the manufacturing literature, OP is commonly assessed using multiple dimensions that reflect a firm's capability to manage

its operations efficiently and effectively. Among the most frequently cited measurement approaches are the four dimensions proposed by Cua et al. (2001): cost, quality, delivery, and flexibility. Building on this foundation, the present study conceptualizes OP through three key dimensions: quality performance, which reflects the ability to produce outputs that meet or exceed quality standards; delivery performance, which assesses the timeliness and reliability of order fulfillment; and operational effectiveness, which captures the overall efficiency and adaptability of production processes. These dimensions collectively offer a comprehensive view of how well a manufacturing firm performs in its core operational activities.

BP is commonly defined as the extent to which a company achieves its market-oriented and financial objectives (Yamin et al., 1999; Cua et al., 2001; Li et al., 2006). In line with this definition, and drawing from the performance measurement frameworks proposed by Cua et al. (2001) and Li et al. (2006), this study operationalizes BP using three key indicators: Return on Sales (ROS), Return on Investment (ROI), and Profitability (PFT). ROS represents a firm's capability to make profit from its sales revenue, calculated as pre-tax income divided by total sales. In this study, ROS is assessed through managerial perceptions using the item: *"The ROS of our plant has increased over the past three years."*

ROI refers to the monetary benefit gained relative to the investment cost, and it serves as a measure of the efficiency or effectiveness of capital allocation. In this study, ROI is measured using the item: *"The overall ROI of our projects has improved in the past three years."* PFT reflects the firm's earnings derived from its core business operations, excluding profits from investments, interest, or taxation effects. PFT is measured based on the item: *"Our company's profit has increased compared to our competitors over the past three years."* These perceptual measures, collected from managerial respondents, provide a comprehensive view of the firm's market and financial performance over a recent three-year period, aligning with prior studies in the field of operations and strategic management.

The Conceptual Framework: The Model And Hypothesis

For this study, the conceptual framework is based on Program Theory, which posits that BP—a fundamental organizational objective—can be attained through better operational processes facilitated by implementing effective management practices. Program Theory elucidates the linkage between inputs, such as lean production practices, the corresponding activities, and the resulting outcomes in terms of BP. Accordingly, this study proposes a conceptual model, illustrated in Figure 1, comprising four primary constructs: (i) SLEAN, (ii) TLEAN, (iii) OP, and (iv) BP

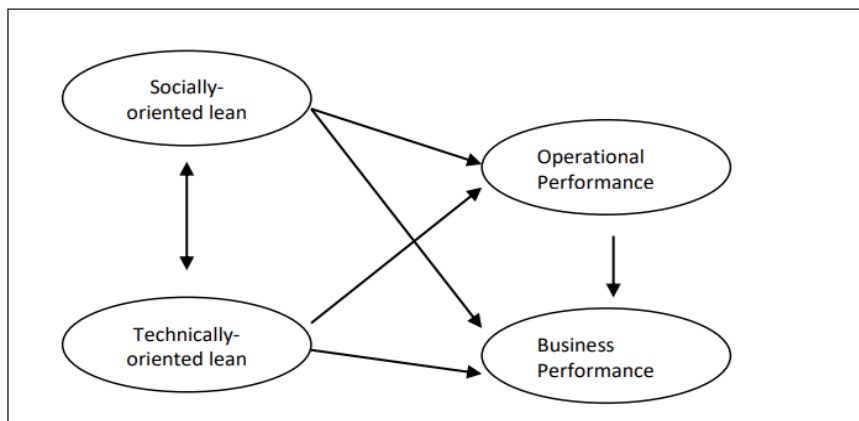


Fig. 1: The Conceptual Framework Presenting The Relationship Between Lean Production, OP And BP

The study posits the following hypotheses to examine the relationships between lean production, OP, and BP.

- H1:** SLEAN have positive relationship with BP.
- H2:** TLEAN have positive relationship with BP.
- H3:** SLEAN have positive relationship with OP.
- H4:** TLEAN have positive relationship with OP.
- H5:** OP is positively associated with BP.

H6: OP mediates the relationship between SLEAN and BP.

H7: OP mediates the relationship between TLEAN and BP.

Research Method

This study employed a cross-sectional research design based on data collection. The unit of analysis was at the company level, with senior managers serving as key informants representing their respective organizations. The sample design was obtained from the Federation of Malaysian Manufacturers Directory, and a simple random sampling method was employed for the sample selection. An overall of 205 usable responses were collected and subsequently analysed using SEM via SPSS and AMOS software packages.

In this study, the research instrument employed was a structured survey questionnaire aimed to evaluate companies across the specified dimensions. The questionnaire comprised of three major parts. First, various constructs related to lean production practices are assessed, while the second part measured multiple performance indicators. The final section collected demographic and profile information about each participating company. Responses were recorded using seven-point Likert scales to capture the degree of agreement or perception. Specifically, the BP measures utilized a seven-point scale reflecting respondents’ assessments of their company’s performance relative to competitors over the past three years following the implementation of lean production practices. Primary data were gathered through multiple channels, including face-to-face interviews, email, telephone, and Google form.

To ensure the robustness of the measurement instruments, both validity and reliability assessments were conducted for the key constructs prior to statistical analysis. The lean production variables used in this study demonstrated strong content validity, as the measurement items were derived from a thorough examination of established literature. Further, subject matter experts evaluated and validated the selected items and constructs in operations management and lean production, supporting their face and content validity. Additionally, the draft questionnaire was pre-tested with academic experts to assess the clarity, relevance, and appropriateness of the content and terminology. Feedback from this pre-test was used for refining the instrument accordingly. Prior to final scale construction, the dataset was examined for normality and outliers, and the results indicated that the data met the necessary assumptions for subsequent multivariate analysis.

Result

This study employed Structural Equation Modelling (SEM) to rigorously examine the relationships between lean production practices, OP, and BP. Initially, Confirmatory Factor Analysis (CFA) was conducted to validate the measurement model, ensuring that the observed variables reliably and validly represented their underlying latent constructs. Following satisfactory CFA results, SEM was executed for testing the hypothesized structural relationship between the constructs within the proposed conceptual framework. The analyses were conducted by the AMOS software package. The findings of the structural model assessment, involving path coefficients and significance levels, are presented in Table 2, providing empirical evidence on the strength and direction of the relationships among SELAN, TLEAN, OP, and BP.

Table 2: Results Of Structural Relationship of the Proposed Method

| Structural Path | Std. Loadings | Std. errors | Critical Ratio | Probability |
|-----------------|---------------|-------------|----------------|-------------|
| SLEAN → BP | 0.027 | 0.370 | 0.147 | 0.883 |
| TLEAN → BP | 0.281 | 0.447 | 1.669 | 0.095 |
| SLEAN → OP | 0.541 | 0.219 | 3.346 | 0.000** |
| TLEAN → OP | 0.349 | 0.278 | 2.243 | 0.025* |
| OP → BP | 0.377 | 0.286 | 1.960 | 0.050* |

**significant at $p \leq 0.01$; *significant $p \leq 0.05$

Hypotheses H1 and H2 posited that both SLEAN and TLEAN would positively associated with BP. However, the empirical findings did not support these assumptions. Specifically, the association between SLEAN and BP obtained was insignificant (critical ratio = 0.147; $p = 0.883$), and the

relationship between TLEAN and BP was also not statistically significant (critical ratio = 1.669; $p = 0.095$). Accordingly, Hypotheses H1 and H2 were not supported.

A plausible explanation for these non-significant findings lies in the nature of lean implementation. The initial stages of lean adoption often involve substantial investments in training, restructuring, and process redesign, which may not immediately translate into measurable financial outcomes. Consequently, improvements in BP—particularly in monetary terms—may only become evident over a longer time horizon.

In contrast, Hypotheses H3 and H4, which proposed positive relationships between SLEAN and TLEAN with OP, were empirically supported. The analysis revealed that SLEAN had a significant positive effect on OP (critical ratio = 3.346; $p = 0.000$), as did TLEAN (critical ratio = 2.243; $p = 0.025$). These findings suggest that both SLEAN and TLEAN contribute meaningfully to enhancing operational efficiency, process reliability, and overall production effectiveness.

Furthermore, Hypothesis H5, which posited a positive association between OP and BP, was also supported. The findings demonstrated a positive association between OP and BP (critical ratio = 1.960; $p = 0.050$). This finding reinforces the view that operational improvements serve as a critical intermediary, translating lean implementation into enhanced business outcomes.

To examine H6 and H7 Hypotheses, which propose the mediating role of OP in the relationship between lean production practices and BP, this study employed a nested model comparison strategy. Specifically, three competing structural models were tested: (i) a partially mediated, (ii) a fully mediated, and (iii) non-mediated models. Each model was specified with appropriate parameter constraints to reflect the respective mediation structure. The model fit indices for all three models are summarized in Table 3, providing a basis for evaluating the presence and strength of the mediating effect of OP in the proposed framework.

Table 3: Fit Indices of the Tested Model

| Statistics | Partially mediated model | Values Fully mediated model | Non-mediated model | Recommended values for good fit |
|---|--------------------------|-----------------------------|--------------------|---------------------------------|
| Chi-square | 103.949 | 253.018 | 252.072 | - |
| Probability Level | 0.060 | 0.006 | 0.004 | ≥ 0.05 |
| Degree of Freedom | 71 | 73 | 72 | - |
| χ^2 / df | 1.464 | 3.466 | 3.501 | ≤ 3.00 |
| Incremental Fit Index (IFI) | 0.972 | 0.871 | 0.870 | ≥ 0.90 |
| Tucker & Lewis Index (TLI) | 0.964 | 0.864 | 0.861 | ≥ 0.90 |
| Comparative Fit Model (CFI) | 0.972 | 0.871 | 0.869 | ≥ 0.90 |
| Normed Fit Index (NFI) | 0.917 | 0.815 | 0.814 | ≥ 0.90 |
| Goodness of fit index (GFI) | 0.929 | 0.827 | 0.827 | ≥ 0.90 |
| Root mean square error of approximation (RMSEA) | 0.048 | 0.088 | 0.070 | ≤ 0.05 |
| ** Assuming partially-mediated model to be correct | | | | |
| Delta-Chi-square ($\Delta\chi^2$) | | 149.069 | 148.123 | ≥ 6.64 |
| Probability Level | | 0.217 | 0.142 | ≤ 0.05 |
| Degree of Freedom | | 2 | 1 | - |

As shown in Table 3, all model fit indices for the partially mediated model met the recommended thresholds for a good model fit, as outlined by Hair et al. (2006). Based on these results, the partially mediated model was determined to provide the best representation of the data among the models tested. Consequently, Hypotheses H6 and H7—which propose that OP mediates the relationships between SLEAN, TLEAN, and BP—were empirically supported.

Conclusion and Implication

While a substantial body of empirical analysis has established the relationship between lean production practices and performance results, there remains a tendency among some studies to treat performance as a homogeneous construct. This study distinguishes between two key dimensions of performance: OP and BP. This distinction is critical, as the effects of lean production may vary depending on the type of performance outcome being assessed. The empirical analysis demonstrated

that both SLEAN and TLEAN orientations was positively associated with OP. This recommends that manufacturing firms implementing lean production practices show notable improvements in operational metrics, such as product quality, delivery reliability, and overall operational efficiency.

In contrast, while the relationships between SLEAN and TLEAN with BP indicators—namely, ROS, ROI, and PFT—are positive in direction, these associations are not statistically significant. This finding implies that lean production implementation, in and of itself, may not lead directly to measurable gains in financial outcomes in the short term. Consequently, expectations regarding the immediate effects of lean practices on financial performance should be tempered, and interpreted with caution. Importantly, the findings indicated that the benefits of lean production may be realized indirectly, primarily through enhancements in OP. Improvements in areas such as quality control, delivery speed, and operational efficiency can contribute to BP over time, albeit not necessarily through direct or immediate financial gains. This suggests a mediating impact of OP on the relationship between lean implementation and BP.

From a managerial perspective, these results show the significance of not only focusing on traditional financial metrics but also monitoring non-financial indicators that reflect operational improvements. Managers should prioritize initiatives that enhance quality performance, reduce cycle times, and improve delivery accuracy as part of a comprehensive lean strategy, recognizing that these operational gains may serve as precursors to longer-term financial success. This study is not without limitations. This research design restricts the capability to draw firm conclusion regarding the causal direction of the observed relationships between lean practices and performance outcomes. To overcome this drawback, future study need to consider longitudinal approaches that track performance metrics over time. Such designs would provide deeper insights into the temporal dynamics and causality underlying the lean-performance relationship, particularly in understanding how operational improvements may translate into BP gains over the long term.

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