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RESEARCH ARTICLE

Effects Of Lean Manufacturing Practices On Operational Performance

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Abstract

Lean manufacturing is a concept of process improvement in production management which focuses on waste elimination. This paper explores relationships between lean manufacturing practices and operational performance. Using data collected from 55 manufacturing companies in Tasikmalaya city. Lean manufacturing were measured by five dimensions: production flow management, customer focus, process management, workforce management, and supplier management. Operational performance comprises four dimensions: cost, quality, lead-time, and flexibility. The findings are that all dimensions of lean manufacturing are significantly related to on operational performance. Production flow management has a higher level of significance in large enterprises compared with SMEs, whereas for customer focus there is a higher level of significance in SMEs compared with large enterprises. Process management, supplier management and workforce management have much lower level of significance for both SMEs and large enterprises.

Keyword: Lean Manufacturing, Operational Performance, Manufacturing Companies, SMEs, Large enterprises

Introduction

The increasing strength of competition in the global market and the customer demand are threating and challenging companies in the international market. Because of that, companies are exploring practical methods to increase their competitiveness by using advanced manufacturing system[1]. Particularly salient among these is the concept of lean manufacturing Since the publication of 'Japanese Manufacturing Techniques' lean manufacturing with its origin from the Toyota manufacturing system has received attention from practitioners and researchers since its introduction[2][3][4][5], The core thrust of lean manufacturing is that these practices can work synergistically to create a streamlined, high quality system that produces finished products at the pace of customer demand with little or no waste [6][7].

By applying lean manufacturing principles, organizations can increase value for customers while improving their profitability alongside citizenship behavior by employees[8][9]. Lean manufacturing has been widely applied in the manufacturing industry around the world and is considered as one of the most effective methods in improvement operational efficiency[10][11][12].

In Tasikmalaya, Indonesia, local manufacturers encounter distinct challenges stemming from fierce competition on both domestic and international fronts. The region's manufacturing industry, which encompasses a wide range of sectors from textiles to footwear, faces considerable pressure to boost efficiency and cut costs to stay competitive. Implementing lean manufacturing principles offers a promising solution to these issues, providing a strategy for local companies to improve their operational performance and meet the growing demands of the global market.

However, organizations face a critical challenge in demonstrating that the implementation of lean manufacturing correlates with tangible improvements in operational performance . This paper aims to examine the relationship between lean manufacturing and operational performance, providing empirical evidence to support the efficacy of lean principles in enhancing organizational outcomes [13][14][15][16][17]. Specifically, this research will focus on the application and impact of lean manufacturing in the manufacturing sector of Tasikmalaya, Indonesia, offering insights into how local firms can leverage these practices to boost their competitiveness and sustainability.

Method

Lean Manufacturing

Lean manufacturing practices were measured by five dimensions, namely production flow management, customer focus, process management, workforce management, and supplier management based on studies [18][19][20] . Lean manufacturing practices are measured on a five-point scale (1) no implementation; (2) little implementation; (3) some implementation; (4) extensive implementation; (5) complete implementation

Operational Performance

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Operational performance comprises four dimensions, namely cost, quality, lead-time, and flexibility [18][19][20] . To measure operational performance, we asked the respondents to rate their firm's performance against its primary competitor in the industry on a five-point Likert scale from "much worse" (1) to "much better" (5).

Method

The method used is a survey method, a method that uses primary data collection by using questionnaires from selected samples[21]. Judging from the goals, this research is intended to get a picture/description of the lean manufacturing practices and correlation with operational performance of the manufacturing industry in Tasikmalaya.

Sample

The samples in this study are all companies in the formal industrial manufacturing sector in Tasikmalaya. Based on the data in the *Kota Tasikmalaya dalam angka*, published by the Central Statistics Agency (BPS –*Biro Pusat Statistik*) of the Tasikmalaya City until 2023, there are 55 companies, such as in table 1.

Procedure

Data collection methods used in this research is the questionnaire, namely a structured questionnaire that is addressed and delivered directly to all managers/leaders of the company's top researchers to obtain data of the lean manufacturing and operational performance. The literature study is also conducted by studying the journals and reports from relevant agencies

Table 1. Formal Industry of 2023 in Tasikmalaya City

Nr.	Sub-Districts	Industrial Category				Total
		Crafts	Chemical & Buildings	Food and Beverages	Clothing and Leather	
1	Kawalu	27	1	-	-	28
2	Tamansari	1	1	2	-	4
3	Cibeureum	2	-	-	-	2
4	Purbaratu	-	-	-	-	-
5	Tawang	2	-	1	-	3
6	Cihideung	2	-	1	-	3
7	Mangkubumi	3	2	-	-	5
8	Indihiang	1	-	-	-	1
9	Bungursari	3	-	-	-	3
10	Cipedes	3	2	-	1	6
TOTAL		44	6	4	1	55

(Source: BPS Kota Tasikmalaya, 2024 processed)

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Scale validity and reliability test

In total, 25 lean manufacturing practices, the result are shown in table 2. The factor loadings of the scales exceed the 0.5 limit indicating that the scales are valid[22]. Lean manufacturing practices produced five dimensions. These are production flow management (five scales), customer focus (five scales, process management (five scales), supplier management (five scales) and workforce management (five scales). The reliability analysis shows that the Cronbach's alpha value for five dimensions is above the threshold value of 0.6 (production flow management = 0.739, customer focus = 0.769, process management = 0.805, supplier management = 0.610, workforce management = 0.750). Thus, these dimensions are reliable[23].

The result of operational performance measure is valid and reliable, shown in Table 3.

The relationships between lean manufacturing practices and operational performance

The responding companies were categorized into two categories – small and medium enterprises (SMEs) and large enterprises. Companies with number of employees ≤ 200 is SMEs than companies with number of employees > 200 is Les. Out of 55 manufacturing companies in Tasikmalaya City, 44 (80%) are SMEs and 11 (20%) are LEs. The relationship between implementation of lean manufacturing practices and operational performance were analyzed separately for these two categories of manufacturing companies. The relationship was investigated using multiple regression analysis.

Small and medium enterprises

The regression analysis was conducted using data from 44 manufacturing companies. The R^2 value (0,266) indicates that overall there is a positive relationship between lean manufacturing practices and operational performance. The results of ANOVA show that this relationship is significant (0.002). Further, the results show that all five dimensions of lean manufacturing impact operational performance. These relationships are significant.

Large enterprises

The regression analysis was conducted using data from 11 companies. The R^2 value (0.330) indicates that a positive relationship exists between lean manufacturing practices and operational performance and the relationship is significant (0.001). However, compared to SMEs, the relationship is higher in case of Large enterprises. The result of the regression analysis show the relationship all five dimension of lean manufacturing practices are significant.

Table 2. Dimensions of lean manufacturing

Lean Manufacturing Practice	Production Flow Management	Customer Focus	Process Management	Supplier Management	Workforce Management
We use a Kanban pull system for production control	0.655				
We have a small amount of work-in-process inventory	0.880				
The layout of the shop floor facilitates low inventories and fast throughput	0.674				
Employees practice set-ups to reduce the time required	0.644				
We usually complete our daily schedule as planned	0.656				
We actively and regularly seek customer inputs to identify their needs and expectations.		0.821			
Customer needs and expectations are effectively disseminated and understood throughout the workforce		0.510			
We systematically and regularly measure customer satisfaction.		0.843			
We have an effective process for resolving customers' complaints.		0.779			
We always maintain a close relationship with our customers and provide them an easy channel for communicating with us.		0.760			
We design processes in our plant to be "fool-proof" (preventive-oriented).			0.869		
We have clear, standardized and documented process instructions which are well understood by our employees.			0.856		
We make an extensive use of statistical techniques (e.g., SPC) to improve the processes and to reduce variation.			0.623		
The concept of the "internal customer" (i.e., the next process down the line) is well understood in our company.			0.747		
We emphasize the continuous improvement of product quality in all work processes.			0.641		
Our suppliers are certificated, or qualified, for product quality.				0.602	
We have long-term arrangements with our suppliers.				0.749	
Our suppliers deliver to us on short notice.				0.505	
We can depend upon on-time delivery from our suppliers.				0.293	
Our suppliers are linked with us by a pull system.				0.701	
Employees receive training to perform multiple tasks.					0.689
Employees are cross-trained at this plant so that they can fill in for others if necessary.					0.713
During problem solving sessions, we make an effort to get all team members' opinions and ideas before making a decision.					0.714
Problem solving teams have helped improve manufacturing processes at this plant.					0.718
Employees inspect the product quality of their own work.					0.722
Cronbach's alpha	0.739	0.769	0.805	0.610	0.750

Table 3. Constructs of lean manufacturing

Operational Performance	Cost	Product Quality	Lead-time	Flexibility
Low production cost.	0.762			
Competitive pricing.	0.790			
Production efficiency.	0.654			
Product reliability.		0.585		
Product performance.		0.555		
Overall product quality as perceived by the customer.		0.552		
Conformance to specifications.		0.661		
Procurement lead time.			0.905	
Manufacturing lead time.			0.868	
Delivery speed/customer lead-time.			0.849	
Easily change the production volume of a manufacturing process.				0.668
Build different products in the same plants at the same time.				0.885
Change over quickly from one product to another.				0.790
Easily modify products to a specific customer need.				0.861
Cronbach alpha	0.559	0.551	0.842	0.808

Table 4. Relationship between lean manufacturing practices and operational performace

size	R2	F/significance	β	t-value	Significance
SMEs	0.266	4.610 / 0.002			
Production flow management			0.263	2.089	0.004
Customer focus			0.313	2.730	0.002
Process management			0.141	1.930	0.016
Supplier management			0.118	1.780	0.044
Workforce management			0.124	1.858	0.040
Large enterprises	0.330	4.830 / 0.001			
Production flow management			0.590	4.547	0.000
Customer focus			0.182	1.779	0.013
Process management			0.115	1.730	0.017
Supplier management			0.200	1.903	0.012
Workforce management			0.295	2.090	0.004

Lean manufacturing practices have been widely adopted across various industries to enhance operational efficiency and performance. This discussion explores the effects of these practices on operational performance, focusing on the comparative analysis between small and medium enterprises (SMEs) and large enterprises (LEs) based on the data collected from 55 manufacturing companies in Tasikmalaya City.

Effects on Small and Medium Enterprises (SMEs)

The regression analysis conducted on data from 44 SMEs shows a positive and significant relationship between lean manufacturing practices and operational performance. The R^2 value of 0.266 indicates that approximately 26.6% of the variability in operational performance can be explained by lean manufacturing practices. The significance of this relationship is further supported by the ANOVA results ($p = 0.002$), confirming that the implementation of lean practices has a statistically significant impact on operational performance in SMEs. Each of the five dimensions of lean manufacturing practices—production flow management, customer focus, process management, supplier management, and workforce management—demonstrated a significant positive effect on operational performance. This suggests that SMEs can achieve substantial improvements in efficiency, quality, and overall performance by adopting comprehensive lean manufacturing strategies. The relatively lower R^2 value in SMEs might be attributed to resource constraints and varying levels of lean implementation maturity compared to larger enterprises.

Effects on Large Enterprises (LEs)

In contrast, the analysis of data from 11 LEs revealed a stronger relationship between lean manufacturing practices and operational performance. The R^2 value of 0.330 suggests that lean practices explain 33.0% of the variance in operational performance, indicating a more pronounced impact compared to SMEs. The relationship is also statistically significant, with the ANOVA results showing a p-value of 0.001. Similar to SMEs, all five dimensions of lean manufacturing practices significantly influenced operational performance in LEs. However, the higher R^2 value in LEs indicates that these larger companies might be better equipped to implement lean practices more effectively, leveraging greater resources, advanced technology, and more structured processes. This enhanced capability allows LEs to realize more substantial gains from lean practices, including higher efficiency, reduced waste, and improved product quality.

The comparative analysis between SMEs and LEs highlights several key insights:

Impact Magnitude: While lean manufacturing practices positively affect operational performance in both SMEs and LEs, the impact is more substantial in LEs. This is reflected in the higher R^2 value for LEs, suggesting that larger enterprises can capitalize more effectively on lean practices.

Resource Utilization: LEs likely benefit from greater resources and more advanced infrastructure, enabling a more comprehensive and effective implementation of lean practices. SMEs, on the other hand, may face limitations in resources and expertise, which can constrain the full realization of lean benefits.

Operational Complexity: The complexity of operations in LEs may also contribute to the higher impact of lean practices. Larger enterprises often have more complex supply chains and production processes, where lean practices can significantly streamline operations and reduce inefficiencies.

Limitation Of The Study

While the study provides valuable insights into the effects of lean manufacturing practices on operational performance, several limitations should be considered:

Sample Size and Representation: The study is based on data from 55 manufacturing companies in Tasikmalaya City, with a significant portion (80%) being SMEs. This relatively small sample size may limit the generalizability of the findings to other regions or industries. Additionally, the disproportionate representation of SMEs compared to LEs might skew the results, making it difficult to draw definitive conclusions for larger enterprises.

Cross-Sectional Design: The study employs a cross-sectional design, which captures data at a single point in time. This approach does not account for changes over time and cannot establish causality. Longitudinal studies would be more effective in understanding how lean manufacturing practices impact operational performance over an extended period.

Self-Reported Data: The data used in the study are self-reported by the companies, which can introduce bias. Respondents might overestimate the extent of their lean manufacturing practices or the improvements in operational performance due to social desirability or other subjective factors. Independent verification of the reported practices and performance metrics could enhance the reliability of the findings.

Conclusion

This research examined the extent to which lean manufacturing practices are adobted by manufacturing companies and their impact on operational performance. The responding were categorized as small and medium enterprises (SMEs) and large enterprises based on number of employees. Using multiple regression models the effect of lean manufacturing practices on operational performance were investigated.

Lean manufacturing practices produced five dimensions. These are production flow management, customer focus, process management, supplier management and workforce management. Production flow management included five item namely: use a Kanban pull system for production control, have a small amount of work-in-process inventory, The layout of the shop floor facilitates low inventories and fast throughput, Employees practice set-ups to reduce the time required, usually complete daily schedule as planned. Customer focus included five items namely: actively and regularly seek customer inputs to identify their needs and expectations, Customer needs and expectations are effectively disseminated and understood throughout the workforce, systematically and regularly measure customer satisfaction, have an effective process for resolving customers' complaints, always maintain a close relationship with our customers and provide them an easy channel for communicating with us. Process management included five items namely: design processes in plant to be "fool-proof" (preventive-oriented), have clear, standardized and documented process instructions which are well understood by employees, make an extensive use of statistical techniques (e.g., SPC) to improve the processes and to reduce variation, The concept of the "internal customer" (i.e., the next process down the line) is well understood in our company, emphasize the continuous improvement of product quality in all work processes. Supplier management included five items namely: suppliers are certificated, or qualified, for product quality, have long-term arrangements with our suppliers, suppliers deliver on short notice, can depend upon on-time delivery from our suppliers, suppliers are linked by a pull system. Workforce management included five items namely: Employees receive training to perform multiple tasks, employees are cross-trained at this plant so that they can fill in for others if necessary, during problem solving sessions, we make an effort to get all team members' opinions and ideas before making a decision, problem solving teams have helped improve manufacturing processes at this plant, employees inspect the product quality of their own work.

The result show that all five dimensions of lean manufacturing dimension are significantly related to operational performance. Production flow management has a higher level of significance in large enterprises compared with SMEs, whereas for customer focus there is a higher level of significance in SMEs compared with large enterprises. Process management, supplier management and workforce management have much lower level of significance for both SMEs and large enterprises.

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