

The Effect of Lean Manufacturing Practices and Knowledge Sharing on Defect Reduction Performance Among Production Workers at a Bicycle Factory, with a Culture of Continuous Improvement as a Mediating Variable

Ariyanta Dany Widyatna*, Mahendra Wisnu Wicaksono, I Made Suparta, I Dewa Ketut Raka Ardiana

Universitas 17 Agustus 1945, Indonesia

Email: 1262500002@surel.untag-sby.ac.id*, 1262500018@surel.untag-sby.ac.id, madesuparta@untag-sby.ac.id, ardiana@untag-sby.ac.id

Keywords	Abstract
Lean Manufacturing Practices; Knowledge Sharing; Continuous Improvement Culture; Defect Reduction Performance.	This study aims to analyze the effect of Lean Manufacturing Practices and Knowledge Sharing on Defect Reduction Performance in bicycle factory production employees with Continuous Improvement Culture as a mediating variable. This study uses a quantitative approach with an associative research type. The research sample amounted to 290 production employees determined based on the number of indicators multiplied by 10. Data collection was carried out through a questionnaire with a Likert scale of 1–5. The data were analyzed using the Structural Equation Modeling-Partial Least Squares (SEM-PLS) method. The results showed that Lean Manufacturing Practices had a positive and significant effect on Defect Reduction Performance with a p-value of 0.000. Knowledge Sharing did not have a significant effect on Defect Reduction Performance with a p-value of 0.572. Lean Manufacturing Practices have a positive and significant effect on Continuous Improvement Culture with a p-value of 0.000. Knowledge Sharing also had a positive and significant effect on Continuous Improvement Culture with a p-value of 0.000. Continuous Improvement Culture has a positive and significant effect on Defect Reduction Performance with a p-value of 0.012. The mediation results show that Continuous Improvement Culture mediates the influence of Lean Manufacturing Practices and Knowledge Sharing on Defect Reduction Performance with a p-value of 0.022 each. This finding indicates that defect reduction is more effective when lean practices and knowledge sharing are supported by a culture of continuous improvement.

INTRODUCTION

The bicycle industry is experiencing significant market changes due to the need for more energy-efficient mobility, healthier lifestyles, and the growth of electric bicycles in many countries. Mordor Intelligence (2026) estimates the global bicycle market value will increase from USD 83.5 billion in 2025 to USD 150.77 billion in 2031 with a CAGR of 10.35%, placing Asia-Pacific as the largest and fastest-growing market. This increase provides opportunities for bicycle manufacturers to increase production capacity, strengthen quality standards, and maintain consistency of assembly results. This opportunity is also evident in Indonesia. World Integrated Trade Solution data shows that Indonesian exports of HS 871200 or bicycles and other types of non-motorized bicycles reached USD 109.32 million in 2024, with the main destinations being the United Kingdom, the United States, Denmark, the Netherlands, and Australia. ANTARA News (2024) also recorded exports of Polygon Kalosi electric bicycles by PT Inera Sena to the

United States and Europe, and stated that most of the main components are sourced domestically and assembled in Indonesia. The data shows that bicycle factories in Indonesia not only serve the domestic market, but also face strict export quality demands.

Strong market opportunities do not automatically guarantee good production performance, as bicycle quality is largely determined by process discipline on the production floor. Small errors in frame welding, painting, wheel installation, brake adjustment, drivetrain assembly, or final inspection can result in defective products, rework, scrap, customer complaints, and additional inspection costs. Defect reduction performance is crucial because it reflects the production line's ability to reduce defects, reduce redundancy, maintain specification compliance, and increase production output that passes initial inspection. Sadikin (2023) emphasized that defect reduction is a crucial aspect of improving manufacturing quality because it is directly related to product quality, customer satisfaction, and operational efficiency. Fragapane et al. (2023) also demonstrated that a zero-defect manufacturing approach can have a positive impact on production performance, although its implementation does not always produce the same results in every company. This means that defect reduction is not solely addressed through final inspection; it needs to be supported by a work system capable of preventing errors from the beginning of the process.

Lean manufacturing practices are a frequently used approach to reduce waste, improve workflow, and reduce production defects. Lean practices such as 5S, standardized work, value stream mapping, visual management, kanban, setup time reduction, root cause analysis, and kaizen encourage a more organized production process. Habib et al. (2023) applied value stream mapping, kanban, setup time reduction, SMED, and why-why analysis to a labeling and packaging factory in Bangladesh; the results showed reduced waiting time, motion waste, and production defects, while lead time, internal complaint rate, and customer complaint rate improved. Hardcopf et al. (2021) found a positive relationship between lean production and several forms of operational performance, including cost, quality, delivery, and flexibility. Deshmukh et al. (2022) also positioned lean manufacturing strategies as a relevant approach to improving productivity and production quality by reducing non-value-added activities. However, lean results often vary between companies because the success of lean practices comes not only from technical tools, but also from worker discipline, supervisor involvement, and the habit of improving processes every day.

Knowledge sharing also plays a crucial role in reducing production defects, particularly in bicycle factories that rely on operator skills, technician experience, and coordination between workstations (Yıldız et al., 2024). Many causes of defects are not necessarily documented in formal procedures but are instead identified through workers' experiences with machines, materials, jigs, fixtures, or recurring error patterns. Myszak (2023) studied 219 manufacturing companies in Poland and found that companies with a broader implementation of lean manufacturing engaged in more formal knowledge sharing, knowledge codification strategies, and widespread knowledge dissemination to support continuous improvement. Shan et al. (2023) also found that knowledge sharing mediated the relationship between supply chain partnerships and innovation performance in 417 manufacturing company respondents. These findings suggest that shared

knowledge is not only useful for innovation but can also serve as a basis for improving production processes because operators can share information about the causes of defects, preventative measures, and the safest work standards to maintain quality.

The relationship between lean manufacturing practices and knowledge sharing on defect reduction performance needs to be examined together because they reinforce each other on the production floor. Lean provides work tools and improvement standards, while knowledge sharing ensures that worker experience doesn't stop with specific individuals. In a bicycle factory, 5S practices can make it easier for operators to find the right work tools, standardized work helps workers follow the same assembly sequence, and root cause analysis helps teams pinpoint the causes of defects more precisely. Knowledge sharing strengthens these processes because senior workers can share how to read defect symptoms, technicians can explain machine failure patterns, and quality control can communicate the dominant types of defects to production operators. Myszak (2023) cites knowledge sharing as a crucial component for continuous improvement in companies implementing lean manufacturing. Fragapane et al. (2023) also identify a zero-defect manufacturing strategy as an area requiring integration of production practices, technology, and performance improvement. Therefore, bicycle factories require synergy between lean practices and knowledge exchange so that defect reduction is not solely the responsibility of quality control.

Continuous improvement culture is appropriate as a mediating variable because it bridges managerial practices with production quality outcomes. Lean and knowledge sharing do not always immediately result in reduced defects if workers only follow procedures under supervision, are reluctant to provide feedback, or are not accustomed to reporting process deviations. Hardcopf et al. (2021) emphasized that organizational culture plays a crucial role in realizing the operational benefits of lean production, and that a developmental culture can maximize the impact of lean on operational performance. Vinodh et al. (2021) reviewed 92 articles related to continuous improvement and Industry 4.0 and identified lean, Six Sigma, kaizen, and sustainability as key strategies for continuous improvement. Palumbo and Douglas (2024) also emphasized the need for research into quality culture as a crucial element for achieving business excellence, especially when companies want to maintain employee energy and creativity for subsequent rounds of improvement. This means that a culture of continuous improvement can be a pathway for transforming lean practices and knowledge sharing into concrete behaviors that prevent defects.

Research gaps are evident in the focus and objectives of previous studies. Habib et al. (2023) discuss the application of lean in a labeling and packaging factory, thus not focusing on a bicycle factory with an assembly process that relies on component conformity and final quality inspection. Hardcopf et al. (2021) demonstrate the influence of lean on operational performance through the role of organizational culture, but do not specifically identify defect reduction performance as a primary outcome for bicycle factory production employees. Myszak (2023) links lean manufacturing with various forms of knowledge sharing in manufacturing companies, but does not examine the pathway of knowledge sharing's influence on defect reduction through a continuous improvement culture. Shan et al. (2023) position knowledge sharing as a mediator of

innovation performance, not as a predictor of defect reduction performance in the production line. Palumbo and Douglas (2024) emphasize the role of culture in quality management, but do not examine a continuous improvement culture as a mediator between lean practices, knowledge sharing, and defect reduction performance.

The novelty of this research lies in four key aspects. First, it introduces continuous improvement culture as a mediating variable that explains the mechanism through which lean manufacturing practices and knowledge sharing influence defect reduction performance—a novel approach in the Indonesian manufacturing literature. Second, it focuses specifically on production workers as the unit of analysis, recognizing that frontline employees are directly exposed to work standards, materials, machines, visual inspections, and daily defect findings. Third, it brings together lean practices, knowledge sharing, and continuous improvement culture in a single mediation model that more closely aligns with bicycle factories' operational reality. Fourth, it provides empirical evidence from the Indonesian bicycle manufacturing context, which has received limited attention in the lean manufacturing and knowledge management literature.

Based on this gap, research on the effect of lean manufacturing practices and knowledge sharing on defect reduction performance among bicycle factory production employees is relevant. Selecting production employees as the unit of analysis is crucial because production line workers are directly exposed to work standards, materials, machines, visual inspections, and daily defect findings. This study not only examines whether lean manufacturing practices and knowledge sharing influence defect reduction but also assesses whether a continuous improvement culture is a pathway that makes both variables work more effectively. This focus provides an update because previous research has focused more on the effects of lean on operational performance in general, knowledge sharing on innovation performance, or quality culture as a supporting factor in quality management. This study brings together these three elements in a mediation model that is more closely aligned with the needs of bicycle factories, namely reducing production defects among workers who carry out daily assembly and quality inspection processes. This study aims to analyze the effect of lean manufacturing practices and knowledge sharing on defect reduction performance among bicycle factory production employees, with continuous improvement culture as a mediating variable.

METHOD

This study uses a quantitative approach with an associative research type. The quantitative approach was chosen because the study examines the relationship between variables through numerical data obtained from questionnaires. The associative research type was used because this study analyzes the effect of Lean Manufacturing Practices and Knowledge Sharing on Defect Reduction Performance with Continuous Improvement Culture as a mediating variable. Creswell and Creswell (2022) explain that quantitative research is used to examine the relationship between variables through measurable instruments and statistical analysis. Hair et al. (2021) also explain that SEM-PLS is suitable for use in research models containing latent constructs and mediating relationships.

The population of this study was bicycle factory production employees directly involved in the production process, assembly, quality control, process maintenance, and work improvement activities. The sampling technique used purposive sampling with the respondent criteria being active production employees, understanding the bicycle production process, and having sufficient work experience to assess lean practices, knowledge sharing, improvement culture, and defect reduction. The determination of the sample size followed the provisions of the number of indicators multiplied by 10, because Hair et al. (2022) suggested an adequate sample size for latent construct-based model analysis. The calculation is Lean Manufacturing Practices 7 indicators + Knowledge Sharing 7 indicators + Defect Reduction Performance 7 indicators + Continuous Improvement Culture 8 indicators = 29 indicators. Therefore, the minimum sample size is $29 \times 10 = 290$ respondents. Data collection was carried out through a closed-ended questionnaire with a Likert scale. The measurement scale uses a range of 1–5, namely 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.

Table 1. Operational Research Variables

No	Variables	Operational Definition	Indicator	Measurement Scale
1	Lean Manufacturing Practices (X1)	Production practices that aim to reduce waste, improve workflow, and maintain the quality of the production process (Gavriliuță et al., 2021).	<ol style="list-style-type: none"> 1) Implementation of 5S in the work area; 2) Value Stream Mapping; 3) Standardization of production work; 4) Just in Time; 5) Kaizen; 6) Poka-yoke; 7) Maintenance of production machines and equipment. 	Likert 1–5
2	Knowledge Sharing (X2)	The process of sharing tacit and explicit knowledge between employees to support problem solving and improve work performance (Ang et al., 2022).	<ol style="list-style-type: none"> 1) Sharing work experiences between operators; 2) Share SOPs, work instructions, and production records; 3) Willingness to provide advice when quality problems occur; 4) Cross-functional discussions between production, quality control, and maintenance; 5) Use of documentation media or production information systems; 6) Willingness to convey process improvement ideas; 	Likert 1–5

No	Variables	Operational Definition	Indicator	Measurement Scale
			7) Learning from senior operators to new operators.	
3	Continuous Improvement Culture (M)	A work culture that encourages employees to be actively involved in problem-solving, process improvement, and standardization of improvement results (Naughton et al., 2024).	1) Leadership support for process improvement; 2) Employee involvement in improvement activities; 3) The habit of looking for the root cause of problems; 4) Implementation of the PDCA cycle; 5) Openness to improvement ideas; 6) Learning from production errors; 7) Standardization of improvement results; 8) Providing feedback on proposed improvements.	Likert 1–5
4	Defect Reduction Performance (Y)	Production capability to reduce defective products, rework, scrap, and repeated defects in the production process (Powell et al., 2022).	1) Reduction in the number of defective products; 2) Reduction in rework rate; 3) Reduction in the amount of scrap; 4) Increased first pass yield; 5) Reduction in quality complaints from the inspection process; 6) Reduced recurrent defects; 7) Increased stability of production processes.	Likert 1–5

Research data analysis was conducted using SEM-PLS through testing *the outer model*, *inner model*, and mediation effects. *Outer model testing* was assessed through *outer loading* with a critical limit ≥ 0.70 , $AVE \geq 0.50$, *Cronbach's Alpha* ≥ 0.70 , *Composite Reliability* ≥ 0.70 , and $HTMT < 0.90$. *Inner model testing* was assessed through path coefficients which were declared significant if the t-statistic > 1.96 and p-value < 0.05 , R-square with categories of 0.75 strong, 0.50 medium, and 0.25 weak, f-square with categories of 0.02 small, 0.15 medium, and 0.35 large, and Q-square > 0 to indicate the predictive ability of the model. The mediating effect of Continuous Improvement Culture is declared significant if the *specific indirect effect value* has a t-statistic > 1.96 and a p-value < 0.05 , so that the mediating variable can explain the path

of influence of Lean Manufacturing Practices and Knowledge Sharing on Defect Reduction Performance (Hair et al., 2021) .

RESULTS AND DISCUSSION

Research result

Respondent characteristics were used to describe the profile of the production employees who served as the research data source. This data is important because the research focuses on employees directly involved in the production process, assembly, quality control, and daily work activities at the bicycle factory. The characteristics of the study respondents are presented in Table 2 below.

Table 2. Characteristics of Research Respondents

Respondent Characteristics	Category	Frequency (n=290)	Percentage (%)
Gender	Man	198	68.3
	Woman	92	31.7
Age	18–25 years	74	25.5
	26–35 years	126	43.4
	36–45 years	67	23.1
	>45 years	23	7.9
	High School/Vocational School	184	63.4
Last education	Diploma	48	16.6
	Bachelor	52	17.9
	Other	6	2.1
	<1 year	36	12.4
Years of service	1–3 years	91	31.4
	4–6 years	83	28.6
	>6 years	80	27.6
	Assembly	96	33.1
Production Department	Frame welding	54	18.6
	Painting	43	14.8
	Quality control	57	19.7
	Production maintenance	40	13.8
Employee Status	Permanent employees	176	60.7
	Contract employees	114	39.3

Table 2 shows that the research respondents were dominated by male employees, amounting to 198 people or 68.3%, while female respondents amounted to 92 people or 31.7%. Based on age, the most respondents were in the 26–35 year group, amounting to 126 people or 43.4%, followed by 18–25 year olds, amounting to 74 people or 25.5%, 36–45 year olds, amounting to 67 people or 23.1%, and over 45 year olds, amounting to 23 people or 7.9%. Based on the last education, the most respondents had a high school/vocational high school education, amounting to 184 people or 63.4%, while respondents had a bachelor's degree, amounting to 52 people or 17.9%, a diploma,

amounting to 48 people or 16.6%, and other categories, amounting to 6 people or 2.1%. Based on the length of service, the respondents mostly had a work period of 1–3 years as many as 91 people or 31.4%, followed by a work period of 4–6 years as many as 83 people or 28.6%, more than 6 years as many as 80 people or 27.6%, and less than 1 year as many as 36 people or 12.4%. Based on the production section, the respondents mostly came from the assembly section as many as 96 people or 33.1%, then quality control as many as 57 people or 19.7%, frame welding as many as 54 people or 18.6%, painting as many as 43 people or 14.8%, and production maintenance as many as 40 people or 13.8%. Based on employment status, respondents were dominated by permanent employees as many as 176 people or 60.7%, while contract employees numbered 114 people or 39.3%.

Outer model evaluation was used to assess construct validity and reliability with critical limits of outer loading ≥ 0.70 , Cronbach's Alpha ≥ 0.70 , Composite Reliability ≥ 0.70 , AVE ≥ 0.50 , and HTMT < 0.90 (Hair et al., 2021). The results of the outer model evaluation are presented in Table 3 below.

Table 3. Outer Model Research Results

Variables	Item	Outer Loading	α	CR	AVE
Lean Manufacturing Practices (X1)	X1.4	0.728	0.84	0.89	0.68
	X1.5	0.858			
	X1.6	0.833			
	X1.7	0.869			
Knowledge Sharing (X2)	X2.3	0.721	0.73	0.83	0.55
	X2.5	0.741			
	X2.6	0.744			
	X2.7	0.763			
Continuous Improvement Culture (M)	M.2	0.736	0.79	0.87	0.62
	M.6	0.798			
	M.7	0.777			
	M.8	0.828			
Defect Reduction Performance (Y)	Y.1	0.783	0.92	0.94	0.7
	Y.2	0.848			
	Y.4	0.803			
	Y.5	0.86			
	Y.6	0.887			
	Y.7	0.851			

Table 3 shows that the evaluation of *the outer model* was carried out by paying attention to the *outer loading value*, *Cronbach's Alpha*, *Composite Reliability*, and *AVE* for each variable. In the Lean Manufacturing Practices variable, items X1.1, X1.2, and X1.3 were eliminated because they did not meet the model feasibility criteria, so the items used in the final model were X1.4, X1.5, X1.6, and X1.7 with *outer loading values* ranging from 0.728 to 0.869. In the Knowledge Sharing variable, items X2.1, X2.2, and X2.4 were eliminated, so the items used in the final model were X2.3, X2.5, X2.6, and

X2.7 with *outer loading values* ranging from 0.721 to 0.763. In the Continuous Improvement Culture variable, items M.1, M.3, M.4, and M.5 were eliminated, so the items used in the final model were M.2, M.6, M.7, and M.8 with *outer loading values* ranging from 0.736 to 0.828. In the Defect Reduction Performance variable, item Y.3 was eliminated, so the items used in the final model were Y.1, Y.2, Y.4, Y.5, Y.6, and Y.7 with *outer loading values* ranging from 0.783 to 0.887. These results indicate that all remaining items have met convergent validity because they have *outer loading values* above 0.70. *The Cronbach's Alpha value* also meets the critical limit because Lean Manufacturing Practices has a value of 0.84, Knowledge Sharing 0.73, Continuous Improvement Culture 0.79, and Defect Reduction Performance 0.92. The *Composite Reliability* value also met the criteria because it was between 0.83 and 0.94. The AVE value for all variables was above 0.50, namely 0.68 for Lean Manufacturing Practices, 0.55 for Knowledge Sharing, 0.62 for Continuous Improvement Culture, and 0.70 for Defect Reduction Performance. Thus, the research constructs have met the requirements for convergent validity and construct reliability.

Discriminant validity is used to ensure that each construct has conceptual differences from other constructs. The HTMT test is considered to meet the criteria if the correlation value between variables is below 0.90. The results of the discriminant validity test are presented in Table 4 below.

Table 4. Results of Discriminant Validity (HTMT)

	Continuous Improvement Culture (M)	Defect Reduction Performance (Y)	Knowledge Sharing (X2)	Lean Manufacturing Practices (X1)
Continuous Improvement Culture (M)				
Defect Reduction Performance (Y)	0.553			
Knowledge Sharing (X2)	0.835	0.479		
Lean Manufacturing Practices (X1)	0.631	0.639	0.601	

Table 4 shows that all HTMT values are below the critical limit of 0.90. The HTMT value between Continuous Improvement Culture and Defect Reduction Performance is 0.553, Knowledge Sharing and Defect Reduction Performance is 0.479, Lean Manufacturing Practices and Defect Reduction Performance is 0.639, Lean Manufacturing Practices and Knowledge Sharing is 0.601, and Lean Manufacturing Practices and Continuous Improvement Culture is 0.631. The highest value is found in the relationship between Knowledge Sharing and Continuous Improvement Culture at 0.835, but this value remains below 0.90. These results indicate that each variable has adequate construct differences, so that discriminant validity has been met.

Inner model evaluation was used to assess the strength of the relationship between variables, with an F-square of 0.02 indicating a small category, 0.15 indicating a medium category, and 0.35 indicating a large category. An R-square of 0.25 indicating a weak category, 0.50 indicating a medium category, and 0.75 indicating a strong category. A Q-square > 0 indicates the model has predictive ability (Hair et al., 2021). The results of the inner model are presented in Table 5 below.

Table 5. Results of the Inner Research Model

Track	f-square	R-square	Q ²
Knowledge Sharing (X2) -> Continuous Improvement Culture (M)	0.379	0.468	0.273
Lean Manufacturing Practices (X1) -> Continuous Improvement Culture (M)	0.109		
Continuous Improvement Culture (M) -> Defect Reduction Performance (Y)	0.037	0.383	0.261
Knowledge Sharing (X2) -> Defect Reduction Performance (Y)	0.002		
Lean Manufacturing Practices (X1) -> Defect Reduction Performance (Y)	0.237		

Table 5 shows that the Knowledge Sharing path to Continuous Improvement Culture has an f-square value of 0.379, so it is included in the large category. The Lean Manufacturing Practices path to Continuous Improvement Culture has an f-square value of 0.109, so it is included in the small to medium category. The Continuous Improvement Culture path to Defect Reduction Performance has an f-square value of 0.037, so it is included in the small category. The Knowledge Sharing path to Defect Reduction Performance has an f-square value of 0.002, so its direct influence is very small. The Lean Manufacturing Practices path to Defect Reduction Performance has an f-square value of 0.237, so it is included in the medium category. The R-square value on Continuous Improvement Culture of 0.468 indicates that Lean Manufacturing Practices and Knowledge Sharing are able to explain 46.8% of the variation in Continuous Improvement Culture. The R-square value on Defect Reduction Performance of 0.383 indicates that Lean Manufacturing Practices, Knowledge Sharing, and Continuous Improvement Culture are able to explain 38.3% of the variation in Defect Reduction Performance. The Q-square value of 0.273 for Continuous Improvement Culture and 0.261 for Defect Reduction Performance indicates that the model has predictive relevance because both values are greater than 0.

Hypothesis testing was conducted to determine the direction and significance of the relationship between variables. A relationship between variables is considered significant if the t-statistic is greater than 1.96 and the p-value is less than 0.05. The results of the research hypothesis testing are presented in Table 6 below.

Table 6. Results of Research Hypothesis Testing

	Hypothesis	β	T statistics	P values	Decision
H 1	Lean Manufacturing Practices (X1) -> Defect Reduction Performance (Y)	0.46	6.93	0.000	Accepted
H 2	Knowledge Sharing (X2) -> Defect Reduction Performance (Y)	0.04	0.566	0.572	Rejected
H 3	Lean Manufacturing Practices (X1) -> Continuous Improvement Culture (M)	0.27	5,787	0.000	Accepted
H 4	Knowledge Sharing (X2) -> Continuous Improvement Culture (M)	0.51	7.42	0.000	Accepted
H 5	Continuous Improvement Culture (M) -> Defect Reduction Performance (Y)	0.21	2,528	0.012	Accepted
H 6	Lean Manufacturing Practices (X1) -> Continuous Improvement Culture (M) -> Defect Reduction Performance (Y)	0.06	2,295	0.022	Accepted
H 7	Knowledge Sharing (X2) -> Continuous Improvement Culture (M) -> Defect Reduction Performance (Y)	0.11	2,295	0.022	Accepted

Table 6 shows that Lean Manufacturing Practices have a positive and significant effect on Defect Reduction Performance with a *p-value* of 0.000 smaller than 0.05, so H1 is accepted. In contrast, Knowledge Sharing does not have a significant effect on Defect Reduction Performance because the *p-value* of 0.572 is greater than 0.05, so H2 is rejected. Furthermore, Lean Manufacturing Practices have a positive and significant effect on Continuous Improvement Culture with a *p-value* of 0.000 smaller than 0.05, so H3 is accepted. The same results are also seen in Knowledge Sharing which has a positive and significant effect on Continuous Improvement Culture with a *p-value* of 0.000 smaller than 0.05, so H4 is accepted. Continuous Improvement Culture is also proven to have a positive and significant effect on Defect Reduction Performance with a *p-value* of 0.012 smaller than 0.05, so H5 is accepted. In the indirect effect, Continuous Improvement Culture mediates the effect of Lean Manufacturing Practices on Defect Reduction Performance with a *p-value* of 0.022 smaller than 0.05, so H6 is accepted. Continuous Improvement Culture also mediates the effect of Knowledge Sharing on Defect Reduction Performance with a *p-value* of 0.022 smaller than 0.05, so H7 is accepted.

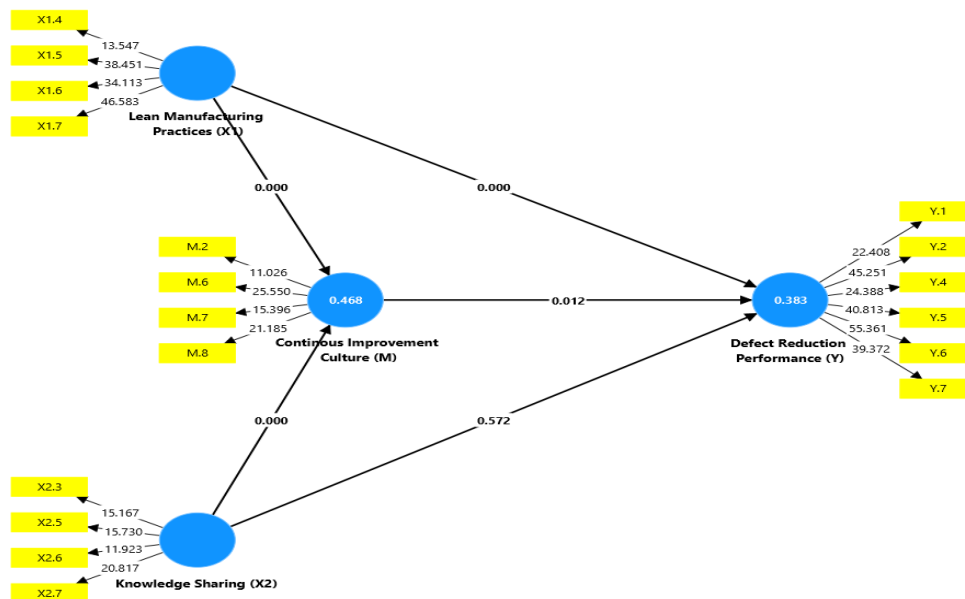


Figure 2. Structural Model Diagram of SEM PLS Research

The results of the study indicate that the relationship model between Lean Manufacturing Practices, Knowledge Sharing, Continuous Improvement Culture, and Defect Reduction Performance has a fairly clear pattern. Lean Manufacturing Practices is the variable that most strongly drives Defect Reduction Performance directly. This is evident from the β value = 0.46 and p-value 0.000, so H1 is accepted. These findings indicate that lean practices such as work standardization, 5S, kaizen, poka-yoke, and production equipment maintenance can help bicycle factory production employees reduce work errors. These results are in line with Panigrahi et al. (2023) who found that lean manufacturing practices have a positive effect on operational performance in manufacturing companies, primarily through quality improvement, process efficiency, and reduction of work waste.

Lean Manufacturing Practices also have a positive and significant effect on Continuous Improvement Culture with a $\beta = 0.27$ and a p-value of 0.000, thus H3 is accepted. These results indicate that lean practices not only impact production techniques but also shape work habits that are more focused on improvement. Employees who are accustomed to working to standards, maintaining a tidy work area, following process flows, and evaluating problems will more easily build a culture of continuous improvement. Hardcopf et al. (2021) emphasized that the success of lean production is strongly influenced by organizational culture because culture determines the extent to which lean practices can produce operational improvements. Myszak (2023) also found that companies implementing lean manufacturing tend to more widely implement formal knowledge sharing and knowledge dissemination practices to support improvement.

Different results were seen in the relationship between Knowledge Sharing and Defect Reduction Performance. A β value of 0.04 with a p-value of 0.572 indicates that the direct effect of Knowledge Sharing on Defect Reduction Performance is not significant, so H2 is rejected. This finding can be explained by the fact that knowledge sharing does not necessarily directly reduce defects if the shared information has not been transformed into work actions, new standards, or consistent process improvements. In a

bicycle factory, employees can share experiences related to welding, painting, assembly, or final inspection defects, but the impact on defects will be weak if there is no follow-up action in production procedures. Loong et al. (2023) found that tacit and explicit knowledge sharing are positively related to manufacturing advantages such as cost, quality, delivery, and flexibility, but this relationship still requires a work system that is able to transform knowledge into operational results.

Knowledge Sharing has been shown to have a positive and significant effect on Continuous Improvement Culture with $\beta = 0.51$ and a p-value of 0.000, thus H4 is accepted. These results indicate that knowledge sharing plays a stronger role in shaping a culture of improvement than as a direct trigger for defect reduction. Production employees who exchange experiences, provide technical advice, explain the causes of errors, and share work solutions will create a production environment that is more open to improvement. Shan et al. (2023) showed that knowledge sharing plays a significant role in improving the innovation performance of manufacturing companies because shared knowledge can strengthen learning and process renewal. The findings of this study extend this direction to the area of production quality, namely that employee knowledge is more effective when it first fosters a culture of continuous improvement.

Continuous Improvement Culture has a positive and significant effect on Defect Reduction Performance with $\beta = 0.21$ and a p-value of 0.012, thus H5 is accepted. This means that a continuous improvement culture can strengthen employee behavior in finding the root cause of defects, conducting process evaluations, and maintaining improvement results so as not to return to old work patterns. The mediation results also show that Continuous Improvement Culture mediates the effect of Lean Manufacturing Practices on Defect Reduction Performance with a p-value of 0.022, thus H6 is accepted. Continuous Improvement Culture also mediates the effect of Knowledge Sharing on Defect Reduction Performance with a p-value of 0.022, thus H7 is accepted. Naughton et al. (2024) showed that implementing a PDCA-based continuous improvement model helps organizations manage process improvement activities in a more structured manner. Powell et al. (2022) also emphasized that the direction of zero defect manufacturing requires a quality system that is able to prevent errors from the start of the process, not only finding defects at the final stage.

CONCLUSION

The results of the study indicate that Lean Manufacturing Practices play an important role in improving Defect Reduction Performance in bicycle factory production employees. Lean practices implemented through work standardization, process improvement, waste control, and error prevention have been proven to be able to directly reduce defects. This is indicated by the positive and significant influence of Lean Manufacturing Practices on Defect Reduction Performance with a p-value of 0.000. Knowledge Sharing does not have a direct effect on Defect Reduction Performance because the p-value of 0.572 is greater than 0.05. These results indicate that the exchange of knowledge between employees is not strong enough to reduce defects if it is not followed by structured corrective actions. Lean Manufacturing Practices and Knowledge Sharing are proven to have a positive and significant effect on Continuous Improvement

Culture with a p-value of 0.000. Continuous Improvement Culture also has a positive and significant effect on Defect Reduction Performance with a p-value of 0.012. In the indirect path, Continuous Improvement Culture is able to mediate the effect of Lean Manufacturing Practices and Knowledge Sharing on Defect Reduction Performance with a p-value of 0.022. These findings confirm that a culture of continuous improvement is a critical link between work practices, knowledge exchange, and the reduction of production defects.

The implications of this research suggest that bicycle factory management needs to consistently strengthen lean practices in the production area. Companies can emphasize the implementation of 5S, work standardization, kaizen, poka-yoke, quality inspections in each process, and maintenance of production equipment to reduce defects from the start. Knowledge sharing needs to be directed into a more structured activity through quality discussions, defect documentation, training between operators, production evaluation meetings, and follow-up on improvement proposals. Companies also need to build a Continuous Improvement Culture by providing space for employees to report problems, convey ideas, find the root cause of defects, and maintain the results of improvements as new work standards. Suggestions for further research include adding other variables such as employee engagement, supervisor support, digital quality control, or production technology readiness to explain the defect reduction model more broadly. Future research can also use other manufacturing industry objects or compare several factories to provide a stronger scope of research results.

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