ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 12| Issue: 6| June 2026|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2026: 8.753 || ISI Value: 1.188

IMPACT OF ARTIFICIAL INTELLIGENCE ON LEAN MANUFACTUIRNG PRACTICES WITH REFERENCE TO MANUFACTURING SECTOR –A PERCEPTUAL STUDY

Dr. Praveen Kumar S
Assistant Professor, Department of Management Studies (MBA), VVIET, Mysuru.

Article DOI: https://doi.org/10.36713/epra28492
DOI No: 10.36713/epra28492

ABSTRACT

Artificial Intelligence plays a crucial role in enhancing the efficiency, productivity, and overall effectiveness of Lean Manufacturing Systems in modern industrial environments. The main aim of this paper is to examine the impact of Artificial Intelligence on Lean Manufacturing Systems in manufacturing firms. The study adopts a quantitative research methodology using a structured questionnaire. A total of 100 respondents were selected, comprising one employee and one production manager from each of the 50 manufacturing firms located in Mysuru. The statistical tools utilized for the analysis include the one sample t test and linear regression. The results reveal that AI has a positive and statistically significant impact on the effectiveness of Lean Manufacturing Systems in manufacturing firms. The study concludes that the integration of Artificial intelligence into Lean Manufacturing practices can substantially improve operational performance and support sustainable industrial growth.

KEYWORD: *Lean Manufacturing, Artificial Intelligence, Operational Efficiency, Waste Minimization, Productivity.*

INTRODUCTION

Artificial Intelligence advanced so quickly that it has drastically changed modern industrial operations, especially in the manufacturing sector, Production systems are progressively using Artificial Technologies like Machine Learning, Predictive analytics and intelligent automation to increase productivity, accuracy and decision making, on the other hand, Lean Manufacturing system concentrate on reducing waste, raising productivity and adding value for customers through ongoing development and effective resource use. By providing real time monitoring, predictive maintenance, quality control and optimal production planning, the integration of Artificial intelligence with Lean Manufacturing principles has the potential to improve operational performances.

Understanding how managers and employees view Artificial intelligence impact on lean manufacturing techniques becomes essential for its successful application in this situation. Their opinions can offer insightful information about the advantages, difficulties and efficacy of implementing AI technologies in production processes. Thus, the purpose of this study is to investigate how AI has affected Lean Manufacturing processes in the manufacturing industry, with an emphasis on manager's and employee's perspectives. The study's conclusion is anticipated to further knowledge of how AI might enhance lean initiatives and boost manufacturing companies overall operational effectiveness.

1. REVIEW OF LITERATURE

Basima Abbood Majeed et al. (2024). The purpose of this research on artificial intelligence and its significance in advancing lean manufacturing was to better comprehend the concepts of artificial intelligence and its ability to contribute to the enhancement of lean manufacturing practices in manufacturing firms. The study used a simple random sample method and questionnaire has been distributed to 300 employees in chosen workplaces and 278 valid responses were assessed. The findings demonstrated that employees broadly recognised artificial intelligence, which played a key role in enhancing administrative efficiency and promoting lean manufacturing tools. The study concluded that combining artificial intelligence with lean manufacturing can improve operational efficiency and performance in manufacturing businesses.

Daryl John Powell (2024). The research article titled "Artificial intelligence in Lean Manufacturing: Digitalization with a Human Touch?". In this study, the author examines the state of research in this field and investigate the growing role of artificial intelligence in Lean manufacturing, Using the literate review as a methodology for the study, 70 papers were chosen for examination and such papers were extracted from Scopus database. The results show that, artificial intelligence promotes lean manufacturing by enhancing operational effectiveness and decision making while highlighting the significance of human participation in digitalized production systems.

Md Foysal Hossain et al. (2023). The authors look at how smart continuous improvement and zero-defect manufacturing are supported in Industry 4.0 contexts by combining artificial intelligence, big data analytics, and lean manufacturing techniques. Using standardized questionnaires, a quantitative survey of 214 experts from eleven manufacturing facilities was carried out. Regression analysis, corelation, and descriptive statistics were used to examine the data. The results show that while AI and Big data also favourably promote enhancement processes, lean technologies are the most powerful force behind intelligent continuous improvement. Furthermore, zero-defect manufacturing performance is greatly enhanced by intelligent continuous improvement. The study comes to the conclusion that while AI and big data should be

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combined to support data-driven decisions and continuous improvement in production systems, lean techniques should be the cornerstone for minimizing defects.

Katarzyna Antosz et al. (2020). The goal of the study undertaken by the authors is to increase the effectiveness of maintenance procedures in manufacturing companies by lowering unplanned machine failures and associated expenses. The study emphasizes the absence of practical techniques for evaluating the degree of lean maintenance implementation. In order to solve this problem, the study uses artificial intelligence methods to find connections between lean maintenance practices and their results. Lean maintenance usage was assessed using rough set theory and decision trees based on the overall equipment effectiveness indicator. RSES software was used to create decision rules, and the accuracy of those rules was evaluated to verify the outcomes.

Guilherme Luz Tortorella et al. (2025). The effect of artificial intelligence on employee engagement in the firms which incorporated Lean manufacturing production methodology is investigated in this study. Twelve academic experts were interviewed as part of the qualitative method, which also included a study with multiple cases of manufacturing companies implementing the lean manufacturing system. The results show that in human centred lean manufacturing work environments. Artificial Intelligence can have a positive impact on employee engagement, especially in the physical, cognitive and emotional domains. The findings also demonstrate how Artificial Intelligence enhances worker's psychological conditions, such as availability, safety and meaningfulness, which facilitate successful lean manufacturing system implementation in the Industry 4.0.

Nasreddine Saasdouli et al. (2025). The integration of artificial intelligence with lean manufacturing systems, which prioritize waste reduction and increased operational efficiency is the subject of this study. The study uses a bibliometric analysis of 186 peer-reviewed publications gathered from Scopus and Web of Science databases to examine the development of this topic between 1993 and 2024. The results show that, with the majority of contributions coming from a small number of developed nations, research on Artificial intelligence and lean manufacturing integration lacks a comprehensive framework and standardized nomenclature. In addition to highlighting important research subjects, the report makes the case that future developments will require more research attention and funding in poor nations.

The increasing significance of artificial intelligence in enhancing operational effectiveness and strengthening lean techniques is highlighted by a few more research. In addition to pointing out obstacles including a lack of expertise and cultural oppositions, Muhammad Usman Tariq et al. (2021) cited important drivers of AI adoption, such as improvements in computing power, data analytics, and cloud technologies. In the exact same way, Mehmet Nurettin Ugural et al. (2024) discovered that the adoption of Artificial Intelligence and lean methods in the construction industry depends heavily on organisation preparedness and leadership support. Additionally, Rajnish Rakholia Et al. (2024) emphasized the use of AI in Industrial domains as process optimisation, quality control and predictive maintenance. Overall, these studies demonstrate that AI improves productivity and decision making: nevertheless, organisational and technological preparedness are necessary for successful adoption.

3. RESEACH GAP

Previous research emphasizes how artificial intelligence can help firms incorporate the lean manufacturing strategies and increase operational efficiency. Numerous scholars have investigated artificial intelligence implementation in domains like operational performance, employee engagement, maintenance systems and continuous improvement (Majeed et al. 2024, Hossain et al 2023 and Antosz et al. 2020). The integration of AI with lean systems and its potential to enhance making decisions and production productivity have also been the subject of several studies (Powell, 2024, Saasdouli et al. 2025). However, there is little emphasis on empirical research based on employee perspectives, and the majority of these studies are conceptual, literature-based, or carried out in developed nations.

Furthermore, very few research (Tariq et al. 2021, Ugural et al., 2024 Rakholia et al., 2024) have looked at the technological and organisational preparedness for AI adoption in Industrial sectors. Studying how artificial intelligence affects lean manufacturing techniques in the Indian manufacturing sector is therefore crucial, especially in regional industrial clusters like Mysuru.

By examining how managers and employees in Mysuru's manufacturing companies view Artificial intelligence and lean manufacturing system, the current study aims to close this gap.

4. RESEARCH PROBLEM

Manufacturing organisations may be unclear about how artificial intelligence may successfully assist lean manufacturing techniques. Therefore, businesses make investments in Artificial technology without properly leveraging them fully, to boost productivity, reduce waste and improve operational efficiency. This could block manager's capacity to make sound decisions about technology adoption with the implementation of lean manufacturing system. Furthermore, the lack of empirical research in the Indian manufacturing context, particularly in locations such as Mysuru, could slow down the proper integration of AI with lean techniques, limiting the growth of the Production methodologies and expertise in this field.

5. NEED FOR THE STUDY

Manufacturing companies are progressively implementing digital technology to boost productivity and competitiveness due to the quick development of artificial intelligence. Lean manufacturing techniques also seek to improve operational performance, increase productivity and decrease waste. However, there is not much empirical data on how AI affects lean manufacturing techniques, especially from the viewpoint of managers and workers in manufacturing companies. Many manufacturing organisations are progressively implementing new technology in places like Mysuru, but it is unclear how much Artificial intelligence helps with lean processes. In order to give businesses useful insights and add to the body of knowledge on Artificial intelligence and Lean manufacturing system, this study is necessary to

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investigate how AI affects lean manufacturing processes in manufacturing companies in Mysuru.

RESEARCH QUESTIONS

1. How does Artificial Intelligence impact on the lean manufacturing system in manufacturing firms in Mysuru?
2. What opinions do managers and employees have on the application of Artificial intelligence in Lean Manufacturing?
3. What steps manufacturing firms in Mysuru can take to better integrate Artificial intelligence with Lean Manufacturing System?

6. OBJECTIVES OF THE STUDY:

- To Study the concept of Artificial Intelligence on Lean Manufacturing System.
- To Evaluate the impact of Artificial Intelligence on Lean Manufacturing System in Manufacturing firms.
- To analyse the perception of managers and employees regarding the use of Artificial intelligence in Lean Manufacturing system.
- To Provide Suggestions for improving the integration of Artificial Intelligence in Lean Manufacturing System.

7. HYPOTHESES FOR THE STUDY:

For the Objective: To Evaluate the impact of Artificial Intelligence on Lean Manufacturing System in Manufacturing firms.

Ho: There is no significant impact of artificial intelligence on Lean manufacturing system in Manufacturing firms.

H1: There is a significant impact of artificial intelligence on Lean manufacturing system in Manufacturing firms.

For the Objective: To analyse the perception of managers and employees regarding the use of Artificial intelligence in Lea Manufacturing system.

Ho: There is unfavourable perception of managers and employees regarding the use of Artificial intelligence in Lean Manufacturing system.

H2: There is favourable perception of managers and employees regarding the use of Artificial intelligence in Lean Manufacturing system.

SCOPE OF THE STUDY

The current study investigates how artificial intelligence impact on Lean Manufacturing systems in Mysuru-based Manufacturing companies. The survey includes 50 manufacturing firms, with one production employee and one manager from each firm selected as respondents. Therefore, the overall sample size of the study is 100 respondents.

The study focuses on understanding the application of Artificial Intelligence and its impact on lean manufacturing system through the opinions of employees and managers in the selected manufacturing firms.

9. LIMITATIONS OF THE STUDY

1. The study's sample size of 100 respondents may limit how broadly the findings may be applied because it is restricted to 50 manufacturing enterprises, each of which has one production employee and one Production Manager.
2. The Data analysis did not categorize manufacturing companies into Small and Medium sized enterprises.

10. RESEARCH METHODOLOGY:

10.1 Population: All the Manufacturing firms in the Mysuru city and the managers and employees working in such manufacturing firms comprises the population for the current study.

10.2 Sample Size: The sample size is 100, consisting of 50 managers and 50 employees from 50 manufacturing firms in Mysuru city (one manager and one employee from each manufacturing firm) with a 95% confidence level. According to Krejice and Morgan Formula ($Z^2 \times p\ (1\text{-}p) \div e2$), the sample size will be 384. Since only 25% of the 384 will be taken into account for the study, the sample size will be 96, rounded to 100.

10.3 Sample Method: Judgemental Sampling method has been considered for the study to draw the sample from the population.

10.4 Data Collection: Both Primary data & Secondary data has been incorporated in the study.

10.4.1 Primary Data: Using a standardized questionnaire, primary data was gathered from managers and employees of manufacturing firms in Mysuru City.

10.4.2 Secondary Data: Through significant textbooks, journals, papers, periodicals, website and other appropriate information from District Industrial Cell (DIC) & Mysore Chamber of Industry and Commerce, secondary data were gathered.

11. Questionnaire Design: There are two sections in the questionnaire: while Section A contains the demographic information of Employee and Managers of the manufacturing firms in Mysuru. Section B Concentrates on how AI affects Lean Manufacturing techniques, and perception of Employee and Mangers of the Manufacturing firms in Mysuru regarding the impact of AI on Lean Manufacturing system. A 5-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly Agree), is used to measure each statement in sections A and B.

12. Statistical tools Used: A one Sample T-Test is performed to examine how managers and staff perceive the effect of AI on the Lean Manufacturing System. Additionally, by determining the impact of AI on Lean Manufacturing system outcomes, linear regression analysis is utilized.

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13. DATA ANALYSIS AND INTERPRETATION

13.1 Demographic Variables:

Table 1: Details of Demographic Variables

1. Gender	**Male**	**Female**	**Others**		**Total**
	72	28	0		**100**
2. Age Group	Below 25 years	25-35 years	36-45 years	Above 46 years	**Total**
	12	26	48	14	**100**
3. Educational Qualification	Diploma	Under Undergraduate	Post Graduate	Others	**Total**
	10	26	60	4	**100**
4. Designation	Employee (Production Department)		Manager ((Production Department)		**Total**
	50		50		**100**
5. Work Experience	Below 2 years	2-5 Years	6-10 Years	Above 10 Years	**Total**
	15	35	28	22	**100**
6. Type of Manufacturing Firm	Small	Medium	Large		**Total**
	17	17	16		**50**

Source: MS Excel Output.

Summary: Out of the 100 Respondents in the survey, 72% are men and 48% are between the ages of 36 and 45. The respondents are split equally between managers and employees (50% each), with the majority (60%) being postgraduates. The majority (35%) have two to five years of Job experience, making them a moderately experienced group. Balanced representation is ensured by the nearly equal distribution of manufacturing enterprises among small, medium and large categories.

13.2 Testing of Hypothesis 1:

Ho: There is no significant impact of artificial intelligence on Lean manufacturing system in Manufacturing firms.

H1: There is a significant impact of artificial intelligence on Lean manufacturing system in Manufacturing firms.

Table 2: Descriptive Statistics: Impact of Artificial Intelligence on Lean Manufacturing System in Manufacturing firms.

Particulars	N	Mean	Std. Dev
AI Supports the effective implementation of 5S Practices in the workplace	100	4.57	.498
AI enhances continuous improvement (Kaizen) initiatives in production processes.	100	4.46	.501
AI improves the efficiency of JIT tool of Lean Manufacturing system.	100	4.46	.501
AI strengthens kanban Lean manufacturing system for better inventory control and workflow management.	100	4.48	.502
AI contributes to the success of Total productive maintenance in reducing machine breakdowns.	100	4.50	.503
AI improves Quality management practices such as Six sigma and SPC in manufacturing.	100	4.43	.498
AI enhances the accuracy and effectiveness of Value Stream Mapping.	100	4.48	.502
AI helps in identifying and eliminating waste (MUDA) in lean manufacturing processes.	100	4.61	.490
AI supports better implementation of continuous flow and process optimization techniques.	100	4.50	.503
AI facilitates the integration of multiple Lean manufacturing tools for overall operational Excellence.	100	4.55	.500
Valid N (Listwise)	100		

Source: Primary Data (SPSS Descriptive Statistics Outcome)

Summary: According the above table 2, the mean score on a 5-point scale ranges from 4.43 to 4.61. this represents that respondents Strongly Agree that artificial intelligence has a strongly impact on lean manufacturing system.

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Table 3: Correlation coefficient for Artificial Intelligence and Lean Manufacturing System

		Artificial Intelligence	Lean Manufacturing System
Pearson Correlation	Lean Manufacturing System	1.000	.782
	Artificial Intelligence	.782	1.000
Sig. (1-tailed)	Lean Manufacturing System	.	0.026
	Artificial Intelligence	0.026	.
N	Lean Manufacturing System	100	100
	Artificial Intelligence	100	100

Source: Linear regression output in SPSS

Interpretation: The above table 3 indicates that there is a positive correlation between artificial Intelligence and Lean manufacturing system, with a correlation value of 0.782 and significance level of .000. This correlation is significant because the p-value is less than 0.05 As a result, the alternative hypothesis is accepted and the null hypothesis is rejected.

Table 4: Regression model summary of Artificial Intelligence and Lean Manufacturing System

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.782[a]	.675	-.005	.16632

Source: Linear regression output in SPSS.

a. Predictors: (Constant), AI_SCORE

Interpretation: The R and R Square values are displayed in the above Table. A high degree of correlation is indicated by the R value, which is 0.782 and shows the simple correlation. The R square score shows much of the overall variation in the lean manufacturing system can be attributed to artificial intelligence. In this instance, an extremely high percentage of 78.2% (.782) can be explained. These findings lead to the conclusion that artificial intelligence has a good ability to predict changes in lean Manufacturing system

Table 5: ANOVA result for Artificial Intelligence and Lean Manufacturing System

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.014	1	.014	.517	.0.026[b]
	Residual	2.711	98	.028		
	Total	2.725	99			

Source: Linear regression output in SPSS

a. Dependent Variable: Lean Manufacturing System

b. Predictors: (Constant), AI_SCORE

Table 6: Analysis of coefficients of the regression model summary of Artificial Intelligence and Lean Manufacturing System

	Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
		B	Std. Error	Beta	t	
1	(Constant)	4.126	.510		8.083	.000
	AI Score	.782	.114	.782	.719	.026

Source: Linear regression output in SPSS

a. Dependent Variable: Lean Manufacturing System.

Interpretation: The above table 5 and 6 indicated that the p-value is less than the normal alpha value of 0.05 and the beta value of Artificial intelligence is not equal to 0 (β=.782≠0), which indicated that a coefficient of 0 indicates that the values of the dependent variable do not consistently differ as the value of the independent variable does. Consequently, the findings showed that artificial intelligence significantly and favourable affects the Lean manufacturing system. As a result, the alternative hypothesis is accepted and the null hypothesis rejected.

13.3 Testing of Hypothesis 2:

Ho: There is unfavourable perception of managers and employees regarding the use ofArtificial intelligence in Lean Manufacturing system.

H2: There is favourable perception of managers and employees regarding the use of Artificial intelligence in Lean Manufacturing system.

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Table 7: Descriptive Statistics: Perception of managers and employees regarding the use of Artificial intelligence in Lean Manufacturing system.

Particulars	N	Mean	Std.Dev
AI improves the effectiveness of lean manufacturing practices	100	4.47	.502
AI helps in enhancing productivity in manufacturing process	100	4.43	.498
AI makes Decision making and more accurate in Production	100	4.55	.500
AI supports continuous improvement (Kaizen) in the organisation	100	4.49	.502
AI helps employees perform their tasks more efficiently	100	4.55	.500
AI improves problem-solving in manufacturing operations	100	4.52	.502
Employees and Managers are comfortable using AI technologies in the workplace.	100	4.55	.500
AI contributes to better coordination and workflow in production	100	4.44	.499
AI enhances the overall performance of lean manufacturing systems.	100	4.47	.502
AI creates a positive impact on employee engagement in production activities	100	4.46	.501
Valid N (Listwise)	100		

Source: Primary Data (SPSS Descriptive Statistics Outcome)

Summary: According to the above table 7, the mean scores on a 5-point scale range from 4.43 to 4.55 this represents that there is a broad consensus among Production managers and employees regarding the application of Artificial intelligence in the lean manufacturing system.

Table 8: One Sample Test: Perception of managers and employees regarding the use of Artificial intelligence in Lean Manufacturing system. (95% Confidence Interval of the Difference)

Particulars	t	df	Sig. (2tailed)	Mean Difference	Lower	Upper
AI improves the effectiveness of lean manufacturing practices	89.112	99	.000	4.470	4.37	4.57
AI helps in enhancing productivity in manufacturing process	89.033	99	.000	4.430	4.33	4.53
AI makes Decision making and more accurate in Production	91.000	99	.000	4.550	4.45	4.65
AI supports continuous improvement (Kaizen) in the organisation	89.368	99	.000	4.490	4.39	4.59
AI helps employees perform their tasks more efficiently	91.000	99	.000	4.550	4.45	4.65
AI improves problem-solving in manufacturing operations	90.019	99	.000	4.520	4.42	4.62
Employees and Managers are comfortable using AI technologies in the workplace.	91.000	99	.000	4.550	4.45	4.65
AI contributes to better coordination and workflow in production	88.998	99	.000	4.440	4.34	4.54
AI enhances the overall performance of lean manufacturing systems.	89.112	99	.000	4.470	4.37	4.57
AI creates a positive impact on employee engagement in production activities	89.038	99	.000	4.460	4.36	4.56

Source: Primary Data (one sample T-test Statistics Outcome)

Interpretation: The above table 8 indicates that, high t-values and significance value of 0.000 ($p<0.05$). representing that the mean differences are statistically significant according to the one sample t test result. On a 5-point scale, the mean score for all the factors all between 4.43 and 4.55 which is around the Strongly agree threshold. This indicates that respondents firmly believe AI has a good impact on lean manufacturing processes. Including productivity, decision making, personnel efficiency, coordination, continuous improvement, and overall system performance. The relevance and dependability of the finding are further supported by the fact that none of the assertions' 95% level contain Zero. Overall, the result show that the application of artificial intelligence in lean manufacturing system is strongly and statistically significantly favored as per the perception of Production Manager and employees, hence, the null hypothesis is rejected and alternative hypothesis is accepted.

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14.RESULT

Objective 2: To Evaluate the impact of Artificial Intelligence on Lean Manufacturing System in Manufacturing firms.		
Hypothesis No	**P-Value**	**Result**
Hypothesis No 1	.026<.05	H_0 Rejected H_1 Accepted
Objective 3: To analyse the perception of managers and employees regarding the use of Artificial intelligence in Lean Manufacturing system.		
Hypothesis No	**P-Value**	**Result**
Hypothesis No 2	.000<.05	H_0 Rejected H_1 Accepted

FINDINGS OF THE STUDY

1. The Study reveals that all the variables assessing how AI affects Lean Manufacturing System have high values, indicating a high degree of agreement among respondents.
2. Artificial intelligence's most important addition to Lean Manufacturing System is its ability to identify and eliminate waste (MUDA) in lean Manufacturing processes.
3. Artificial intelligence facilitates the successful application of 5S techniques in the workplace, demonstrating how AI enhances efficiency and organisation in the workplace.
4. In terms of Perception, Artificial Intelligence helps employees do their tasks more effectively and improves decision making in production, demonstrating a high level of acceptance of Artificial among employees and managers
5. Among all the variables, manufacturing's use of AI to enhance quality management techniques like Six sigma and SPC had the lowest value (mean score 4.33, compare to others), but still reflecting a favourable opinion.

SUGGESTIONS

1. Manufacturing companies should go from simple AI applications to self-learning and autonomous systems that can autonomously optimize production, anticipate problems, and take remedial action with little assistance from humans.
2. To achieve end-to-end lean optimization, the manufacturing firms extern Artificial Intelligence integration beyond shop-floor operations to supply chain, procurement, logistics and customer demand forecasting.
3. The manufacturing firms should boost AI-powered dashboards and real time data to facilitate quicker and more precise decision making, cutting down on delays and enhancing responsiveness in Lean Manufacturing System.
4. To remain competitive and significantly improve productivity, quality and waste reduction, AI technologies such as Machine learning, computer vision and digital twins must be continuously upgraded by the manufacturing firms.
5. Manufacturing firms should train the employees regarding the use of Artificial intelligence and technology, increase awareness and technical proficiency to boost adoption at all organisational level and minimizes resistance.

CONCLUSION

Lean Manufacturing systems in manufacturing companies are significantly and favorably impacted by artificial intelligence, It improves important procedures including staff productivity, decision-making workplace organisation, and waste reduction. The overall results show that AI is widely accepted and beneficial in supporting lean manufacturing processes, even though some areas, such as workflow coordination and quality control, still need improvement.

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