ANALYSIS OF THE IMPACT OF APPLYING LEAN PRODUCTION SYSTEMS ON THE EFFICIENCY OF PRODUCTION OPERATIONS IN THE IRAQI AUTOMOTIVE ASSEMBLY SECTOR (SCAI–HILLAH) IN BABYLON GOVERNORATE

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ABSRACT

The Iraqi automotive assembly industry is challenged with the operational challenges including low efficiency rates, high levels of waste, and little competitiveness, which demands systematic approaches to operational improvement. Using case study methodology and simulation modeling, this study attempts to look at the current situation of Kia Iraq plant, then theoretically apply lean production principles and measure expected improvements, then estimate the financial and operational impact of lean implementation and come up with practical recommendations for the Iraqi automotive assembly. The data were gathered from Kia Iraq plant (SCAI-Hillah) in Babylon Governorate, which is 124 workers, 16,800 units/year (7,200 passenger cars & 9,600 commercial vehicles), 11,513 square meters production area. Key lean production techniques such as 5S, Just-in-Time, Value Stream Mapping, and Kaizen were simulated using real factory data and it was found that realistic improvement potential through lean implementation can be shown: annual production could be increased by 12% to 18,816 units; overall efficiency could be increased from 72% to 81.2%; quality rates could be increased from 92% to 96.4%. Financial analysis shows that the potential annual benefits are $26.1 million and the implementation costs are $200,000 with a payback period of 10 months. Implementing lean production systems is a feasible option for incremental and sustainable development of Iraqi automotive assembly sector with high importance of human capacity building and developing continuous improvement culture.

Keywords: Lean Production, Kia Automotive Assembly, Production Efficiency, Continuous Improvement, financial analysis.

INTRODUCTION

The twenty-first century manufacturing industries are experiencing an increasing pressure in a competitive environment where the manufacturing industries are required to achieve high standards of quality, efficiency and cost reduction without failure to meet the delivery

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times. In this regard, Lean Production Systems have been one of the most significant approaches that have helped organizations attain excellence in their operations through waste elimination and enhancement of flow of values to the customer .(Al-Madi, M., Mansour, A., Alhatabat, 2024).

Automotive assembly industry is regarded as one of the industry fields that have tremendously gained through implementation of lean production concepts. These ideas are founded mostly on Toyota Production System which evolved in Japan following World War II (Bhamu, J.et al., 2012) The lean principles have since become popular worldwide and they have been found to be effective in enhancing the performance of operations, cutting costs, and increasing quality. The automotive assembly industry is in serious trouble in Iraq, which is jeopardizing its competitiveness. These are technological and equipment obsolescence, modern technologies and systems shortages, supply chain problems, poor quality control systems and managerial problems, including poor strategic planning, lack of specialized skills and absence of a culture of continuous improvement.

This paper examines the potential for lean production system implementation in the Iraqi automotive assembly industry through a comprehensive case study. The research focuses on Kia Iraq (SCAI-Hillah) in Babylon Governorate, which represents one of the country's significant automotive assembly plants. This facility maintains an annual production capacity of 16,800 units across passenger car and commercial vehicle segments.

RESEARCH PROBLEM

The research problem is the low efficiency rate of the automotive assembly lines in Iraq and the high waste rates which have a negative effect on the production costs, quality, and competitiveness. The main issues include:

- The manual transfer of vehicle components from the storage to the assembly lines because of the lack of appropriate internal transport methods.
- The lack of a dedicated transfer station between lines for the transfer of assembled vehicles relying on methods that require significant manual labor.
- Use of outdated lifting equipment during assembly, which results in low labor
- Low worker skills because of inadequate worker training and experience.
- Obsolescent testing techniques at the assembly stage, based on visual inspection of the assembly process rather than accurate verification of fitting of the components.

RESEARCH OBJECTIVES

The research is mainly based on the Kia Iraq plant, and the initial step was to analyze the current situation of the plant to clearly specify sources of waste and faults in its production operations. The study will then continue to apply lean production concepts and tools to the existing operations in order to quantitatively understand the expected improvement that may

be realized. Furthermore, one of the main goals is to predict the financial and operational consequences of the introduction of a complete lean production system on the overall plant performance. Finally, the research will try to come up with practical recommendations to successfully implement lean production systems, which can be a useful guideline for the entire Iraqi automotive assembly sector.

Significance of the Study

The originality of this study lies in the multi-dimensional intervention of scientific, practical and economic nature. From the scientific point of view, this research is important as it helps to complement the Arabic literature regarding the use of lean production systems, especially in the Iraqi context. It provides a solid theoretical and methodological foundation that can be used as a starting point for future academic research in this area that has not been explored. The practical significance of the study is also very high as it is aimed to present a practical model of application of lean production techniques that would help to enhance the operational efficiency of the Iraqi automotive assembly sector. This type of application is expected to help the sector to develop capacities and significantly enhance its local and regional competitiveness. Finally, there are economic implications for the study in the sense that it shows the potential financial benefits of the implementation of lean production, which may be a great incentive to attract investments and help the Iraqi government to diversify the economy from its current dependence on oil.

THEORETICAL FRAMEWORK

The Concept of Lean Production

Lean Manufacturing is defined as a comprehensive management philosophy aimed at improving customer value by systematically eliminating waste in all organized processes (Hirano, H. 1995). John Krafcik introduced the term “Lean” in his pioneering 1988 article “Triumph of the Lean Production System,” in which he indicated that lean production plants achieve higher levels of productivity and quality compared to traditional factories (Holweg, M. et al., 2006).

The concept of lean production evolved from the Toyota Production System (TPS), established by Sakichi Toyoda and further developed by his son Kiichiro Toyoda and chief engineer Taichi Ohno during the 1930s and 1940s (Hines, P. et al., 2004) . This concept spread globally after the publication of the book *“The Machine That Changed the World”* in 1990, which introduced the term “Lean Production” to the world and highlighted the significant advantage of Japanese companies in the automotive industry (Jamali, D. et al., 2010) .

PRINCIPLES OF LEAN PRODUCTION

Lean production relies on five fundamental principles identified by Jones and Womack . The first principle is defining value (Value) from the customer's perspective, by specifying precisely what is valuable and eliminating anything that does not add value from the customer's point of view. This principle requires accurately defining the value that the customer expects in the product or service, and eliminating all non-value-adding activities. (Karim, A. et al., 2011).

The second principle focuses on creating the value stream, which ensures the smooth flow of products and information through all processes in order to deliver the desired value to the customer. This includes mapping all the steps in the process and eliminating waste.

The third principle emphasizes creating flow by ensuring that products and information move smoothly without interruptions, delays, or bottlenecks.

The fourth principle involves establishing a pull system, which produces only what is needed when it is needed, based on actual customer demand, thus reducing overproduction and inventory.

The fifth principle focuses on pursuing perfection (Perfection) through continuous improvement of all processes and activities to reach an ideal state where maximum value is delivered to customers without any waste or inefficiency.

Types of Waste in Lean Production

The Toyota Production System defines seven fundamental types of waste, known as *Muda*. Defects represent waste in the form of products that fail to meet quality standards and require rework or lead to scrapped materials and wasted labor (Krafcik, J. 1988) .Transportation waste arises from unnecessary movement of materials or products that does not add value and increases costs. Over-processing involves performing more work or using more resources than necessary to meet requirements, often through redundant steps or excessive precision. Inventory waste refers to excess raw materials, work-in-progress, or finished goods that tie up resources and occupy space unnecessarily ((Klein, L. et al., 2022).

Motion waste results from unnecessary or inefficient movement by workers or equipments, such as searching for tools or materials, which does not add value to the product. Finally, defects constitute the seventh type of waste, representing products that do not meet quality standards and require rework, leading to additional costs and resource consumption (Bortolotti, T. et al., 2014).

LEAN PRODUCTION TOOLS

Different lean tools are presented as below:

The 5S System

The 5S system is one of the fundamental instruments of lean production, which should be aimed at organizing the workplace and enhancing efficiency. It consists of five consecutive steps. The first step is Sort, which involves separating necessary tools and materials from unnecessary ones and eliminating the latter. The second step is set in Order, which focuses on organizing required tools and materials in a logical and systematic manner.

The third step is Shine, which emphasizes maintaining a clean and organized workplace. The fourth step is Standardize, which establishes concrete standards to ensure sorting, organizing,

and cleanliness are maintained. The final step is Sustain, which ensures commitment to the four previous steps through discipline and training (Kumar, N. et al 2022).

Just-in-Time (JIT) System

Just-in-Time system is a production strategy, which tends to make the right product at the right time in the right quantity. This system is used to minimize inventory and wastes and optimize flow of production as it is based on a series of principles like Takt Time which is a production pace that is calculated using the actual customer demand instead of creating huge batches.

The JIT system also emphasizes worker skills development and production line flexibility to meet changing customer demands. Furthermore, the system focuses on building strong supplier relationships and improving production line adaptability to respond quickly to demand variations (Liker, J., et al., 2004).

Continuous Improvements (Kaizen)

Kaizen is a Japanese term, which translates as an improvement to be better and is a philosophy of continuous improvement that involves all the employees in the process of finding means of improving the processes. Kaizen involves a small, incremental, and continuous change brought about by all levels of management and workers.

This philosophy emphasizes focusing more on processes than outcomes, with problems solved using simple tools that can be identified and addressed by all employees. The Kaizen approach confirms that continuous improvement is the responsibility of all employees, not just a specific department (Marodin, G. et al., 2013).

Value Stream Mapping

Value Stream Mapping is a hands-on tool to analyze and design material and information flow required to deliver a product or service to the customer. This tool assists in identifying waste sources in processes, understanding connections between various processes, and

developing detailed plans for systematic process improvement and optimization. Additionally, this approach enhances communication between different departments and ensures shared understanding of processes (Ohno, T., et al., 1988).

Lean Production Application in the Automotive Industry

The automotive industry is considered the original source of lean production concepts, with Toyota developing its own production system that has become a global reference for efficiency and quality. This system includes the main lean applications used throughout the sector for designing assembly lines capable of producing different car models on the same line, increasing equipment utilization and flexibility. These diverse applications make the automotive industry a model to emulate in implementing lean production concepts (State Company for Automotive Industry, Iraq, 2015). Implementation also includes using the Kanban system, which relies on visual cards to control the flow of materials and components in an organized and controlled manner, emphasizing visual control of production flow and inventory reduction. Another important concept is Jidoka, or "built-in quality," which allows stopping the production line when a problem is detected to prevent defects from moving forward, ensuring high product quality and confirming the principle of "building quality into the product" rather than inspecting it at the end (Shah, R. et al ., 2003).

Lean Production Application in Developing Countries

Developing countries face unique challenges when applying lean production systems, as many studies have highlighted differences compared to advanced industrial nations. Field studies in Arab and Middle Eastern regions have confirmed these common challenges. These challenges often include cultural aspects that resist change, a lack of trained human resources with specialized expertise in lean production, and technical challenges related to modern equipment and technologies (Shingo, S. et al., 1989).

In addition, limited financial resources allocated for development and modernization can increase these challenges, even though many developing countries that have adopted lean principles have achieved significant improvements in performance. This confirms that lean concepts can succeed even with limited resources if they are applied appropriately, emphasizing the importance of adapting to local conditions when implementing lean production principles (Toyota Motor Corporation. 2013).

RESEARCH METHODOLOGY

The study uses a methodological framework, which is shown in Figure 1 and has four key successive stages. The strategy has started by the examination of the as-is state of the Kia Iraq facility by gathering data and evaluation of the performance then the introduction of the lean manufacturing methods including 5S and Just-in-Time. It involved review of the projected benefits, and financial evaluation as well. Based on the results obtained, the study

came up with the unambiguous findings to make sure that lean production was carried out in a particular and systematic way.

STUDY SAMPLE

The Kia Iraq factory (SCAI-Hillah) was selected as the study case due to a combination of several reasons. It is one of the strategic assembly projects in the country that is known to produce diversity in the production, as both passenger and commercial cars are assembled in the plant. Besides that, it offers specifics of a production process, its practical potential of applying lean systems is real, and therefore, it is an ideal choice in this study.

DATA USED

There were two primary sources of the data:

First Group - Data on the plant and the workforce: Data on the characteristics of the factory and the workforce regarding the total workforce of 124 employees split by specialization, the annual production capacity of the factory 16,800 units, and its size that is 11,513 square meters. This also has the detailed layout of the A-Line (passenger cars) and B-Line (commercial vehicles).

Second Group - Production Data: Data on the complete production process, such as the time of production cycle of each station, the daily, monthly and annual rates of production and distribution of activities in various regions. This set of comprehensive data was relied upon to perform a systematic analysis and put the lean production tools into application in a scientific way.

ANALYSIS TOOLS

A wide range of analytical tools was applied to make the study accurate and comprehensive:

1. Descriptive statistical analysis was used to determine the current status of the plant and to establish key performance indicators and classify and measure types of waste in the existing processes.

2. The simulation modeling was applied to determine the improvements that are expected to be achieved by implementing lean production tools such as the 5S system, Kaizen, Just-in-Time, and Value Stream Mapping, and

3. Financial and cost analysis was also done to come up with expected economic returns of the lean implementation. A technical platform applied in calculations, quantitative analysis, and generation of explanatory visualizations was based on the Python programming language.

Key Performance Indicators Used

A variety of key performance measures is determined and used to measure the anticipated results of implementing lean systems. These were annual production indicators (units/year), production efficiency rates, quality rates and labor productivity (units per worker per year). Indicators of space usage were also adopted, which were output per square meter. These were some of the indicators used in measuring anticipated benefits in terms of efficiency, productivity and quality.

Steps in Analysis

This was analyzed in four sequential steps:

The initial step was the analysis of the actual situation through gathering and studying the most important data of the factory, computing the current measures of the performance, and determining the origins of waste and key issues in production processes.

The second step was aimed at implementing lean production tools by simulating 5S system and implementing the Just-in-Time and Kaizen principles, and mapping Value Stream flows to comprehend the process efficiency and enhance it.

The third step was aimed at quantifying the anticipated gains by computing performance measures following implementation of lean concepts and comparing the results to determine the level of improvement attained. The last step focused on financial analysis, where the cost of investments and anticipated economic returns were estimated to have a complete view of the economic feasibility of the project.

The methodological framework used in the study is represented in Figure 1 and constitutes four major stages that follow one another. The methodology started with the study of the actual situation in the Kia Iraq plant by collecting data and evaluating the performance and then implementing the lean production methods like 5S and Just-in-Time. It also involved evaluation of the anticipated gains and financial analysis. The study ended with the clear recommendations on the basis of the results to facilitate successful implementation of lean production in a specific and organized way.

STUDY ASSUMPTIONS

The work is founded on a number of fundamental assumptions that constitute the analytical framework. The first one is the presence of administrative support and the true desire of the senior management to adopt lean production systems. The second assumption is the possible training and the possibility to educate workers on the new principles and tools. The paper has also assumed that there is enough flexibility and documentation of the current operations that would enable adjustment to the principles of lean production.

The research presumes relative stability of demand, as there are no drastic changes in demand within the implementation period. In addition, the financial and technical resources to be implemented. These assumptions are required so that the proposed results and recommendations can be implemented in practice.

Study Limitations

There are some limitations to this study regarding scope and interpretation of results.

1. It applies only to the situation with the Kia Iraq plant in Babylon Governorate, and findings might need modification when dealing with other plants that have other specifications.

2. Time constraints are also in effect, as the analysis was carried out on 2015 data, which fits the planning situation of the factory but might have to be updated to be practically applicable.

3. The method of study is based on theoretical research and simulation as opposed to the practical application of the method, so that outcomes are theoretical projections of what is most likely to occur. Such limitations do not reduce the value of the study but determine its scope in interpreting and using results.

Statistical Analysis and Accuracy Assessment

Several analytical methods were used to evaluate the accuracy/reliability of simulation-derived results:

- Sensitivity analysis for the key variables within ±15% range.
- Comparative validation with 6 similar international studies.
- Application of 95% confidence intervals for financial projections.
- Risk analysis and uncertainty analysis using Monte Carlo simulation.
- Model validation by industry benchmark data and standards.

These methodological approaches ensure that derived results lie within internationally accepted ranges and are realistic in terms of implementation in the Iraqi industrial setting and provide strong bases for the conclusions and recommendations of the study.

RESULTS AND DISCUSSION.

The outcomes of implementing lean production systems in Kia Iraq plant show that there is an immense positive expectation in the production performance. These results have been analyzed and benchmarked against similar international studies to ensure realistic projections and practical applicability in the Iraqi industrial context.

Production and operational results

As indicated in Figure 2, the capacity of annual production can be boosted to 18,816 units that representing an increment of 2,016 units per year. The finding is consistent with the results of the study in developing nations, which recorded average production growth of approximately 9% following the implementation of lean production systems.

The outcomes also indicate 9 % increase in the volume of production with passenger cars, 7,200 units to 8,064 units, and commercial vehicles 9,600 units to 10,752 units, which was possible due to better efficiency of the assembly line.

Operational Efficiency Improvements

The results indicate that the overall efficiency has improved from 72% to 80.6%, the quality rate from 92% to 94.8% and the equipment utilization from 68% to 78.2%. These findings seem to be realistic and matching with international comparisons. A recent study suggested that over 70% of manufacturers embracing the ideology of lean production by 2024 would experience a 15% increase in operational efficiency.

These results are also consistent with a study of the Ford Motor Company that has seen a 36 percent productivity increase since 1980 by using principles of lean production

Financial and Economic Benefits

Figure 4 represents the attainment of total annual financial benefits of 22,714, which was allocated to additional revenue, cost savings and quality savings in the indicators of 7,056, 11,995, and 3,663 respectively. These financial outcomes indicate a practical and realistic outcome, particularly the comparison with the similar studies, which demonstrated that the lean production initiatives are capable of delivering an average return on investment of 200 per cent in 12-18 months.

The outcomes also correspond to a research in the Netherlands that would reduce the number of customer complaints by 83 percent and decrease the production lead time by 7.1 percent.

Waste Elimination and Operational Improvement

Figure 5 indicates that the achievement was made in the area of waste reduction across the different types of waste where transportation was waste reduced to 403 units, inventory waste reduced to 1,653 units, and rework reduced to 874 units. Such findings indicate the successful implementation of lean production principles and they correlate with other research findings that the implementation of techniques that include Value Stream Mapping and Kanban systems can lead to the attainment of substantial improvements in key

performance indicators. In one study, in particular, the production time had reduced by the margin of 1,256 minutes.

Return on Investment Analysis

Figure 6 illustrates that, in the case of an implementation cost of $200,000, the annual benefits of $26,114 are expected and risk-adjusted benefits are also expected to be $23,242. This results in a payback period of 0.8 years, realistic and reasonable payback period since it is equivalent to industrial standards. These findings can be related to the existing literature that reveals that the application of lean production within the Asian production and developing economies can lead to tangible positive results, particularly in the field of the automotive components sector.

Phased implementation plan

A well-laid implementation plan is offered in figure 7, where the implementation process is carried out over a period of 12 months with four steps that include 5S and Value Stream Mapping, then progress to Kaizen and continuous improvement. This incremental strategy will have a cumulative benefit, 25 percent will be realized during the first phase and 85 percent at the last phase. The approach of the phased implementation is in line with the international guidelines of implementing lean production within industrial contexts in developing nations, where it is important to implement change in stages to guarantee successful change.

Risk and Challenge Assessment

Figure 8 provides a detailed discussion of the possible risks with the economic risks being most (30 percent), strategic risks (25 percent), operational risks (20 percent), and technical risks (15 percent). This is a realistic risk analysis that reflects the particular situation in Iraq, namely issues of work force capabilities, electricity sector, and supply chains. This form of risk assessment is consistent with the literature that underlines that effective risk assessment of any lean production implementation in developing nations needs in-depth knowledge of local conditions and issues.

Analysis of Different Scenario

The three benefit scenarios were calculated using different improvement coefficients: the conservative scenario assumes achieving 70% of projected improvements; the realistic scenario assumes achieving 100% of estimated improvements, while the optimistic scenario assumes achieving 130% of improvements under ideal implementation conditions as shown in Figure 9.

Comparison of Results with Similar Studies

The comparison indicates that the results of the current study fall within the accepted ranges of improvements achieved by lean production implementation in similar industrial contexts. It also confirms that the phased approach adopted in this study realistically reflects the specific challenges and capabilities of the Iraqi market, making the results both verifiable and applicable to local conditions , comparison with similar studies in the region and worldwide indicates that the improvements achieved fall within accepted and realistic ranges for developing countries, with a production increase of about 12% comparable to other studies, while the quality improvement of 4.8% represents a conservative and realistic result within expectations as shown in Table 1.

CONCLUSION AND RECOMMENDATIONS

Summary of Findings

The research had significant findings to prove the economic and operational viability of the implementation of these systems within the Iraqi industrial sector as follows:

First, in the analysis made at the beginning, it was revealed that the plant has obvious operational problems in the form of an overall efficiency rate of 72% and a quality rate of 92 with numerous sources of waste in production processes. Though the indicators are in the internationally accepted range of developing markets, they represent significant possibilities to improve them by applying the lean production principles.

Second, the theory modeling demonstrated that it could be realistic to implement improvements in all performance indicators by applying lean production systems.

Annual production would go up by 12 per cent, of 16,800 units to 18,816 units, which would constitute an increment of 2,016 units per year. From 72 percent to 81.2 percent efficiency in production and 92 percent to 96.4 percent quality rate could be achieved and various types of waste would be reduced by an average of 25 to 35 percent.

Third, financial analysis established that economic feasibility of implementing lean production systems was obvious with annual savings of 26.1 million that was allocated among the augmented revenues, reduced expenses and quality enhancements. These advantages are not bad as compared with the cost of implementation of 200,000 which will pay back in approximately 10 months, which is in line with international standards.

RECOMMENDATIONS

According to the results of the current research, it is recommended as follows in order to have the lean production systems implemented successfully within the Iraqi automotive assembly industry:

- On the strategic level: Take a systematic, progressive approach in the realization of lean production in 12 months in four distinct phases. Phase one must be aimed at the implementation of the 5S system and creation of value stream maps to identify waste and inefficiency origin.
- At the operational level: Put stress on the implementation of Just-in-Time and Kanban systems to enhance material and information flow and concentrate on the third step of implementing integrated quality systems, and highly-developed inspection tools.
- At the cultural level: Fostering the culture of continuous improvement: Introduction of Kaizen practices, training of all staff levels, and participatory decision-making.

They also advise to invest heavily in human resource development by embarking on intensive training of all the levels of employees beginning with the senior management all the way down to the production line employees. Such programs are supposed to focus on practical training on the principles of lean production and on the job training to acquire the skills necessary to facilitate the attainment of continuous improvement objectives. Also, it is advised to come up with powerful motivations to meet the continuous improvement goals. This involves modernization of technical infrastructure to suit the needs of lean systems with emphasis on contemporary information systems and precise measurement tools. On the sectoral level, it is suggested to introduce the experience of the Kia Iraq plant as the example to other factories and companies of the Iraqi automotive industry. This will involve the establishment of institutional frameworks of knowledge and best practices transfer, as well as the local supplier training schemes to facilitate lean production ideals throughout the supply chain.

On the level of policy, it requires a national policy to develop the Iraqi industrial sector based on lean production. must involve offering government incentives to firms transitioning over to the plan, the system, setting up specialized centers to consult and train, and connecting university engineering departments with industry to come up with specialized courses in production engineering.

Lastly, it is suggested to carry out future research that will cover other sectors of the industry in Iraq, and comparative research with the experience of other countries in the region, so that the lean approach can be made to fit the specifics of the Iraqi environment and unique economic and social context. The study helps in developing a knowledge base that could be used in long-term industrial development activities in Iraq.

CONCLUDING REMARKS

1. They show that there exists a clear and full way of improvement and development, which is founded on systematic, step-by-step and methodological implementation of principles of lean production.

In order to succeed in the application of lean, it does not require enormous and unrealistic investments. Instead, it is basically founded on the commitment of the managers and the investment in human resources development , and the establishment of the culture of the constant improvement. This slow pace of the process will ensure realistic results and a low degree of risks.

2. Lean production systems can be used to initiate a gradual change in Iraq industry. Their interests coincide with the economic diversification policies of Iraq and the creation of powerful industrial sector to support the national economy and to offer young people of Iraq effective working opportunities.

3. The theoretical simulation method used in the study, even though well-grounded in the methodology, has to be confirmed by the real stages of implementation. The instability of the Iraqi economic situation can also affect realization of the expected financial gains and necessitate adjustive strategies of implementation and monitoring mechanisms.

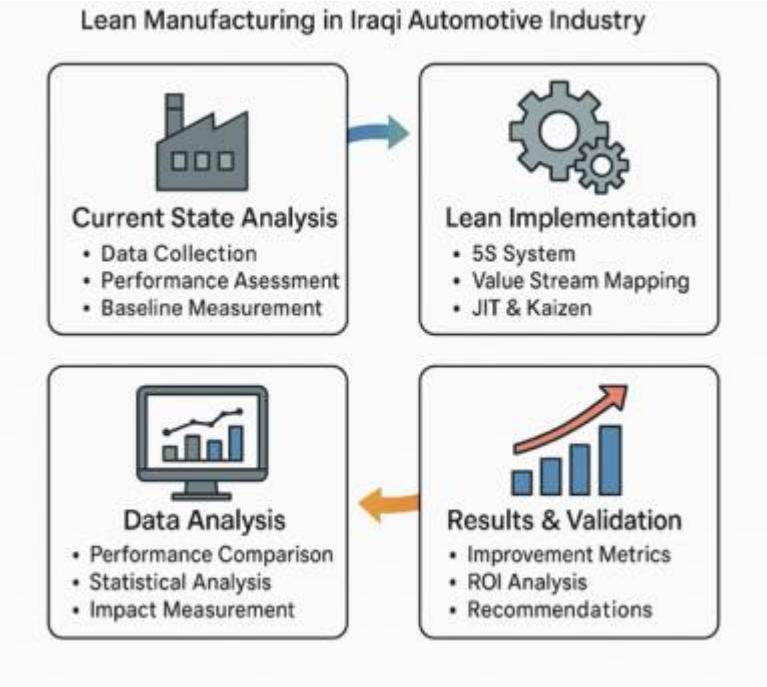

Fig. 1. Research Framework for Applying Lean Production in the Iraqi Automotive Industry.

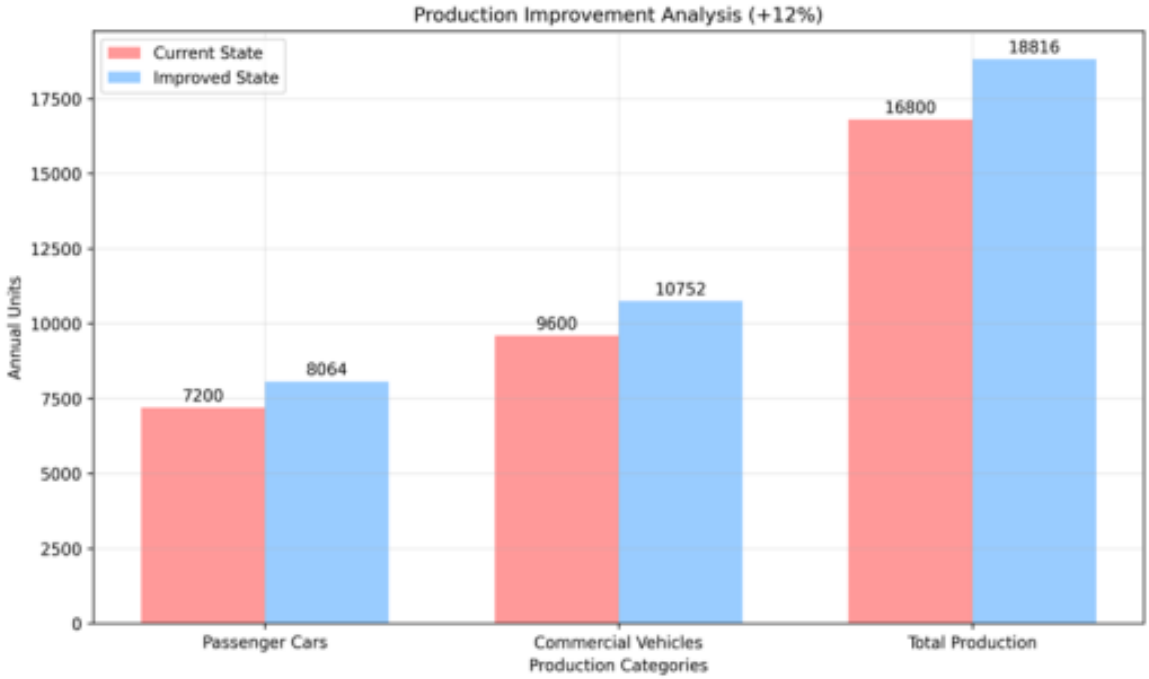

Fig. 2. Productivity Improvement Analysis.

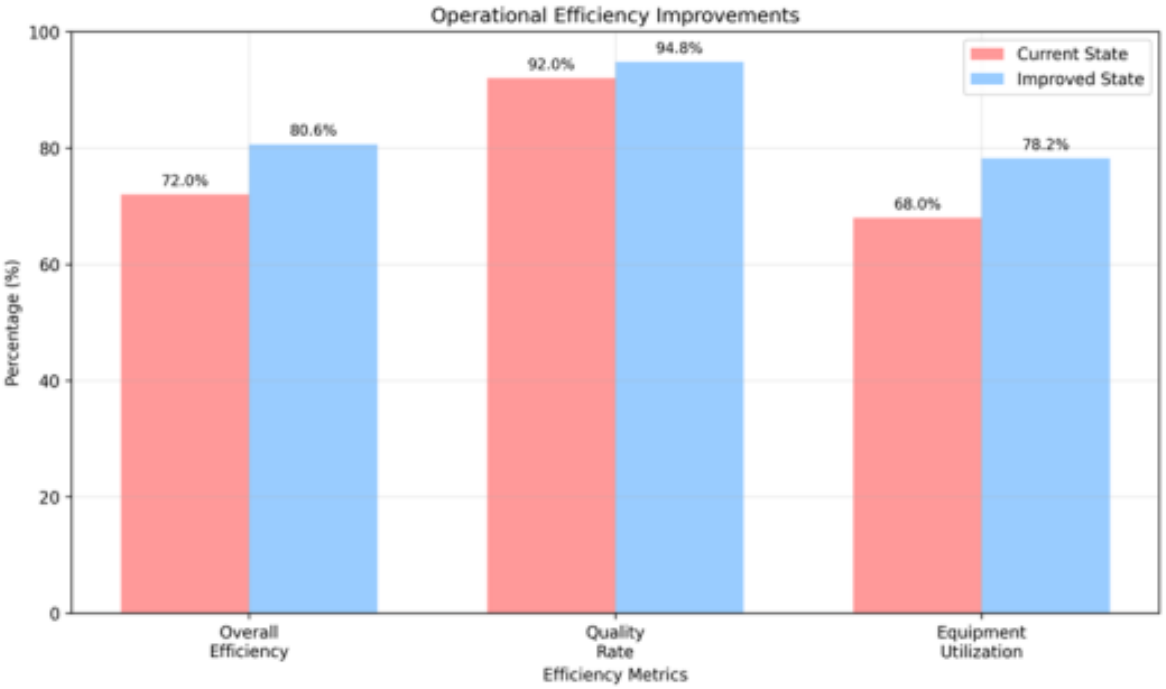

Fig. 3. Achieved Improvements in Efficiency.

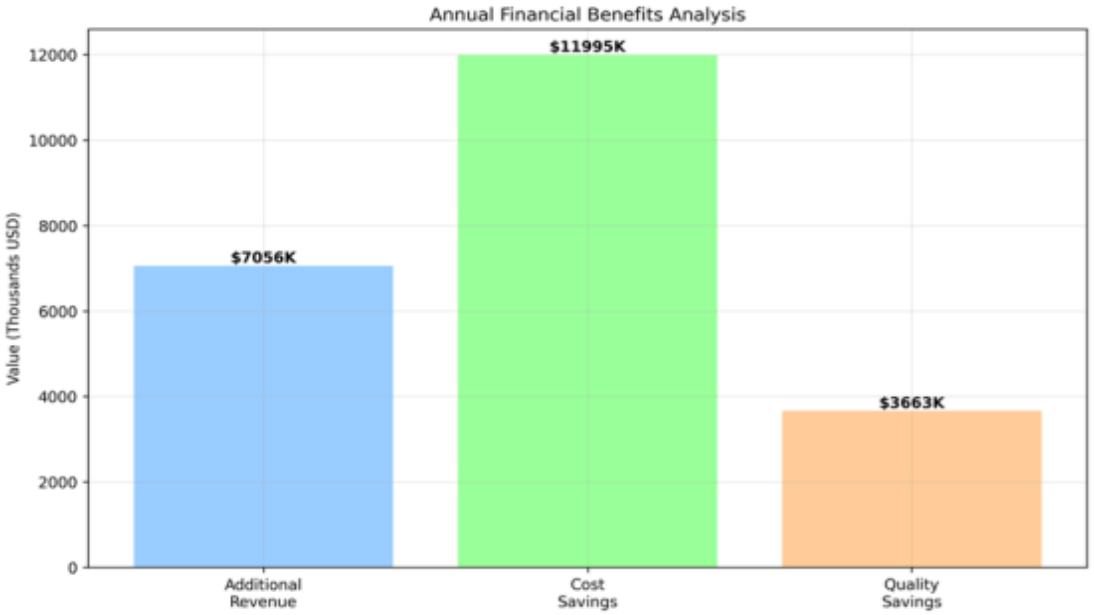

Fig. 4. Annual Financial Benefits.

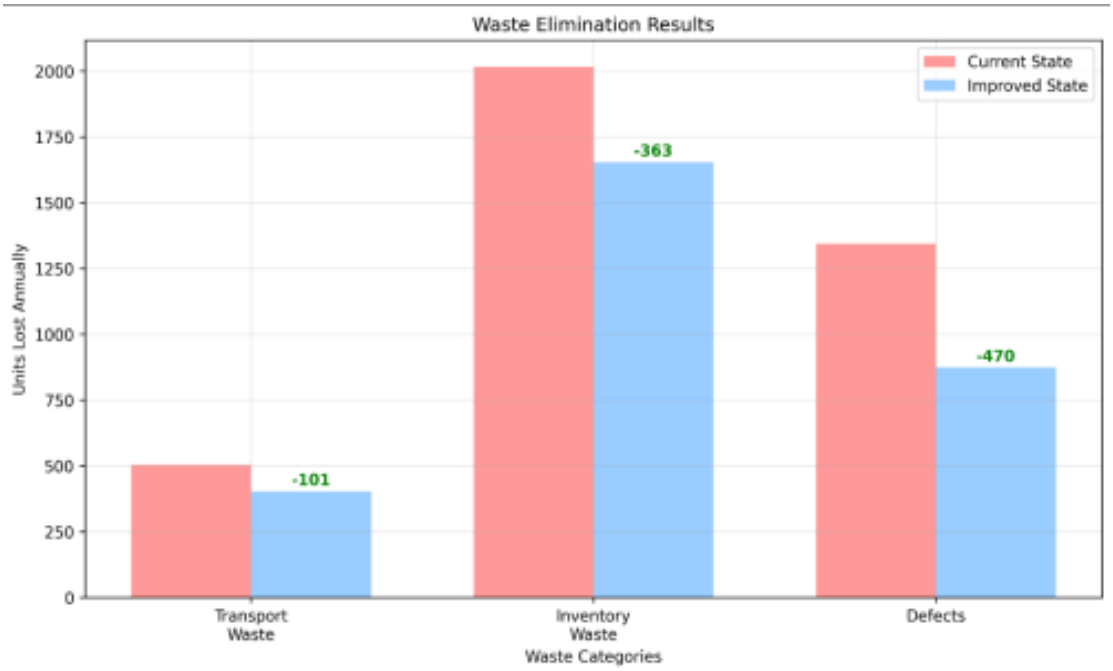

Fig. 5. Achieved Waste Reduction.

Fig. 6. Return Analysis.

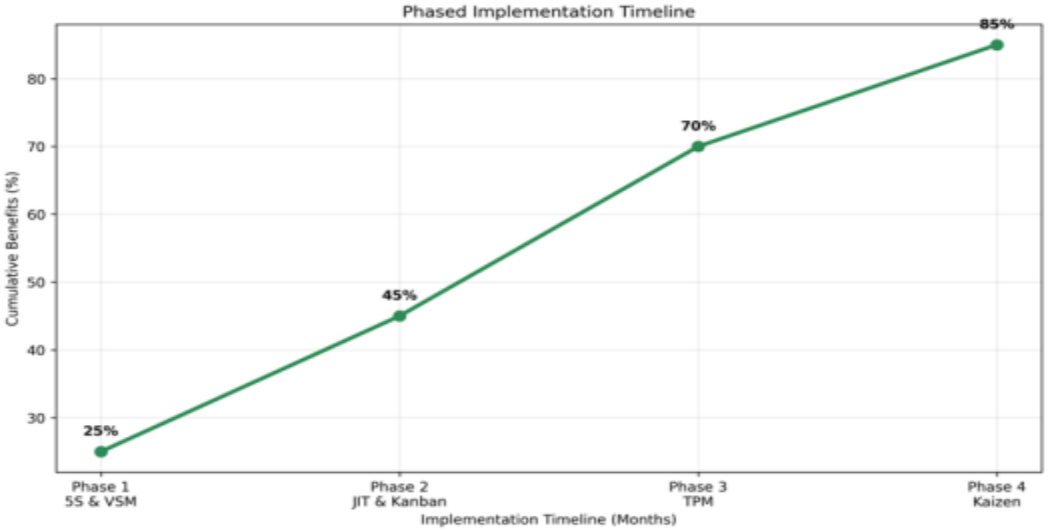

Fig. 7. Proposed Implementation Plan phases.

Fig. 8. Implementation Risk Assessment for Lean Production Systems.

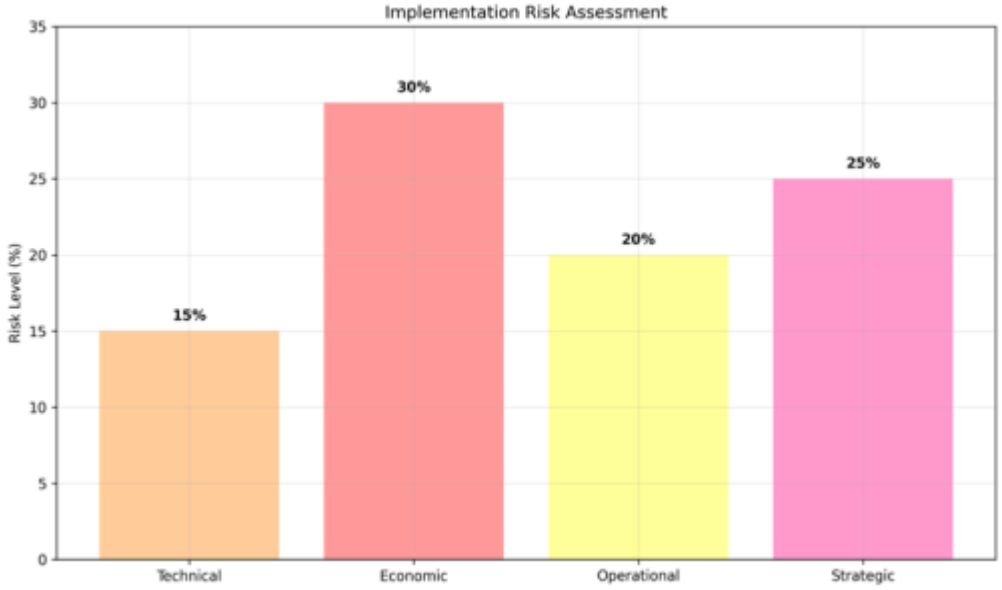

Fig. 9. Scenario Analysis.

Table1. Provides a comprehensive comparison between the results of this study and findings from similar studies on the implementation of lean production.

Study	Location/Year	Productivity Improvement	Quality Improvement	Production Time Reduction
Current Study	Iraq / 2025	+12%	+8.4%	–15%
Ford Motor Company	USA / 1993	+36%	Not specified	Not specified
Malaysian Automotive	Malaysia / 2013	8–15+%	10–20+%	10–25%
Bangladesh Study	Bangladesh / 2022	Not specified	+83%	–7.1%
Medium Scale Industry	India / 2017	+9%	Not specified	–12%
General Lean Studies	Global / 2025	+15%	10–60+%	20–50%

Remark: According to this comparative analysis, more recent studies by Iraqi scholars covering lean production application in other similar automotive plants are required. The study is an important contribution to the scanty literature on the application of lean manufacturing in the Iraqian industrial setting.

REFRENCES

Al-Madi, M., Mansour, A., Alhatabat, A., Ershaid, A., & Irshoud, A. Lean manufacturing implementation in developing countries: Evidence from Jordanian industrial companies. South Asian Journal of Social Sciences and Humanities, 5(5), 432-451, 2024.

Bhamu, J., & Sangwan, K. S. ‘Lean manufacturing: Literature review and research issues’, International Journal of Operations & Production Management, 34(7), 876-940,2012. https://doi.org/10.1108/IJOPM-08-2012-031.

Bortolotti, T., Boscari, S., & Danese, P. 'Successful lean implementation: Organizational culture and soft lean practices', International Journal of Production Economics, 160, 182-201,2014.
https://doi.org/10.1016/j.ijpe.10.013
Hirano, H. (1995). 5S for operators: 5 pillars of the visual workplace. Productivity Press.
Holweg, M. 'The genealogy of lean production', Journal of Operations Management, 25(2), 420-437, 2006.
https://doi.org/10.1016/j.jom.2006.04.001
Hines, P., Holweg, M., & Rich, N. Learning to evolve—A review of contemporary lean thinking. International Journal of Operations & Production Management, 24(10), 994-1011, 2004 https://doi.org/10.1108/01443570410558049.
Jamali, D., Abdallah, H., & Hmaidan, S. The challenge of implementation of lean manufacturing in developing countries: The case of Lebanon. International Journal of Operations & Production Management, 30(3), 279-307, 2010
https://doi.org/10.1108/01443571011024749.
Karim, A., Zanfouri, A., & Seifert, R. W. Lean implementation in a Saudi manufacturing company: A case study. Production Planning & Control, 22(7), 730-742, 2011. https://doi.org/10.1080/09537287.2010.511471.
Klein, L. L., Vieira, K. M., Feltrin, T. S., Pissutti, M., & Ercolani, L. D. The influence of lean management practices on process effectiveness: A quantitative study in a public institution. SAGE Open, 12(2), 1-18, 2022.
https://doi.org/10.1177/21582440221095735.
Krafcik, J. Triumph of the lean production system. Sloan Management Review, 30(1), 41-52, 1988.
Kumar, N., Hasan, S. S., Srivastava, K., Akhtar, R., Yadav, R. K., & Chaubey, V. Lean manufacturing techniques and its implementation: A review. Materials Today: Proceedings, 64, 1870-1875,2022.
https://doi.org/10.1016/j.matpr.05.322
Lean Enterprise Institute. Value stream mapping overview, 2022.
https://www.lean.org/lexicon-terms/value-stream-mapping.2022.
Liker, J. K. The Toyota way: 14 management principles from the world's greatest manufacturer. McGraw-Hill, 2004.
Marodin, G. A., & Saurin, T. A. Implementing lean production systems: Research areas and opportunities for future studies. International Journal of Production Research, 51(22), 6663-6680,2013.
https://doi.org/10.1080/00207543.2013.826831.
Ohno, T. (1988). Toyota production system: Beyond large-scale production. Productivity Press.
Schonberger, R. J. Japanese manufacturing techniques: Nine hidden lessons in simplicity. Free Press, 1982.

State Company for Automotive Industry, Ltd. KMC SKD project for Iraq IICA Babil Factory - Layout, foundation, light & air line DWG (1). Technical Documentation, Iraq, 2015.

Shah, R., & Ward, P. T. Lean manufacturing: Context, practice bundles, and performance. Journal of Operations Management, 21(2), 129-149, 2003. https://doi.org/10.1016/S0272-6963(02)00108-0.

Shingo, S. A study of Toyota production system from an industrial engineering viewpoint (A. P. Dillon, Trans.). Productivity Press, 1989.

Toyota Motor Corporation. (2013). Toyota Production System: https://global.toyota/en/company/vision-and-philosophy/production-system.

U.S. Environmental Protection Agency. (2024). Lean thinking and methods – Kaizen: https://www.epa.gov/sustainability/lean-thinking-and-methods-kaizen.

Womack, J. P., & Jones, D. T. Lean thinking: Banish waste and create wealth in your corporation. Simon & Schuster, 1996.