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Lean Manufacturing in Libyan Industrial Enterprises: A Critical Review of Challenges, Opportunities, and a Contextual Implementation Framework

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التصنيع الرشيق في المؤسسات الصناعية الليبية: مراجعة نقدية للتحديات والفرص وإطار التنفيذ السياقي

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Abstract
In light of increasing industrial competition and global transformations, adopting advanced production systems has become vital to enhancing the competitiveness of industrial enterprises. This paper presents a semi-systematic critical review of the published literature on the application of lean manufacturing in Libyan industrial enterprises during the period from 2010 to 2023. The findings reveal that practical application remains limited and sporadic, facing multi-level managerial, organizational, technical, and cultural challenges. Key obstacles include weak senior management commitment, a lack of specialized training, inadequate support infrastructure, and resistance to change by traditional organizational culture. The paper proposes a four-pronged implementation framework based on: strategic leadership, capacity building, contextual adaptation, and performance measurement. It also offers practical recommendations for industry practitioners, researchers, and policymakers to enable the systematic and sustainable adoption of lean manufacturing in Libya, emphasizing local specificities and drawing on international experiences in the context of reconstruction and industrial development.

Keywords: Lean manufacturing, perations management, waste reduction, continuous improvement, contextual adaptation**.**

الملخص
في ظل تزايد المنافسة الصناعية والتحولات العالمية، أصبح تبني أنظمة إنتاج متقدمة أمرًا حيويًا لتعزيز القدرة التنافسية للمؤسسات الصناعية. تقدم هذه الورقة مراجعة نقدية شبه منهجية للأدبيات المنشورة حول تطبيق التصنيع الرشيق في المؤسسات الصناعية الليبية خلال الفترة من 2010 إلى 2023. تكشف النتائج أن التطبيق العملي لا يزال محدودًا ومتقطعًا، ويواجه تحديات إدارية وتنظيمية وفنية وثقافية متعددة المستويات. تشمل العقبات الرئيسية ضعف التزام الإدارة العليا، ونقص التدريب المتخصص، وعدم كفاية البنية التحتية الداعمة، ومقاومة التغيير من قبل الثقافة التنظيمية التقليدية. تقترح الورقة إطارًا تنفيذيًا رباعي المحاور يعتمد على: القيادة الاستراتيجية، وبناء القدرات، والتكيف مع السياق، وقياس الأداء. كما تقدم توصيات عملية للممارسين في الصناعة والباحثين وصانعي السياسات لتمكين التبني المنهجي والمستدام للتصنيع الرشيق في ليبيا، مع التركيز على الخصوصيات المحلية والاستفادة من التجارب الدولية في سياق إعادة الإعمار والتنمية الصناعية.

الكلمات المفتاحية: التصنيع الرشيق، إدارة العمليات، تقليل النفايات، التحسين المستمر، التكيف مع السياق.

1. Introduction

With the accelerating pace of global industrial competition and the continuous fluctuations occurring in international markets, manufacturing organizations particularly in developing economies such as Libya are increasingly required to enhance productivity, improve product quality, and reduce various forms of operational waste in order to maintain competitiveness. Within this context, lean manufacturing has emerged as one of the most influential contemporary production management philosophies, as it provides a structured approach for eliminating non-value-adding activities, streamlining processes, and improving overall organizational performance. Over recent decades, lean principles have been successfully institutionalized in a wide range of industries worldwide; however, their application within the Libyan industrial environment remains largely limited, fragmented, and insufficiently embedded in organizational practice.

1.1 Problem Statement

Despite the global success of lean manufacturing in improving operational performance and supporting industrial competitiveness, its implementation within the Libyan context continues to face considerable challenges. The available literature points to a persistent gap between conceptual understanding of lean principles and their actual application in Libyan industrial enterprises. This gap can be summarized through three dimensions:

- **Knowledge Gap:** limited availability of comprehensive and systematic research that clearly describes the real status of lean adoption in Libyan industries and identifies the contextual factors influencing its effectiveness.
- **Implementation Gap:** absence of a practical and context-sensitive implementation roadmap capable of guiding organizations toward gradual, structured, and sustainable lean transformation.
- **Policy Gap:** lack of a clearly articulated national strategy that supports lean manufacturing as a pillar within wider industrial modernization and post-conflict reconstruction efforts.

These challenges are further complicated by Libya's broader political, economic, and infrastructural conditions, which increase uncertainty and hinder sustained improvement initiatives.

1.2 Study Objectives

This study aims to achieve the following objectives:

Main Objective: To conduct a comprehensive critical and analytical review of the literature related to the application of lean manufacturing in Libyan industrial institutions during the period 2010-2023.

Sub-Objectives:

- To identify and analyze the most prominent administrative, organizational, technical, and cultural challenges facing the implementation of lean manufacturing in Libya.
- To assess the current level of adoption of lean manufacturing tools and practices in various Libyan industrial sectors.
- To draw lessons learned from local, regional, and international studies with similar contexts.
- To develop a practical implementation framework that takes into account the specificities of Libya and provides a road map for the systematic application of lean manufacturing.
- To provide practical recommendations for researchers, practitioners, and policymakers to promote the adoption of Lean Manufacturing in Libya.

1.3 Previous Local Studies

Local research generally confirms that lean implementation in Libyan industrial enterprises remains in an initial developmental stage. Many studies report that application is often limited to individual tools rather than adoption of a comprehensive lean system. Research findings indicate that although some organizations have introduced practices such as basic workplace organization or selective value stream analysis, implementation remains constrained primarily by weak managerial commitment, inadequate financial resources, and limited technical capabilities.Other local studies highlight the influence of organizational culture, demonstrating that resistance to change and adherence to traditional management styles significantly reduce the likelihood of achieving effective lean transformation. Assessments of organizational readiness reveal that many Libyan industrial institutions still lack the required leadership capacity, skills, and structured improvement mechanisms necessary to institutionalize Lean or Lean Six Sigma practices successfully.

1.4 Significance of the Study

This study is significant for several reasons:

Academically: It fills a research gap in the literature related to lean manufacturing in Arab contexts, particularly in Libya.

Practically: It provides an implementation framework that Libyan industrial institutions can use as a guide in their journey towards lean manufacturing.

Politically: It offers recommendations to policymakers that help integrate lean manufacturing concepts into national industrial policies.
Socially: It contributes to promoting a culture of continuous improvement and efficiency, which can positively impact economic development.

2. The Theoretical Framework of Lean Manufacturing

Lean manufacturing represents a comprehensive management philosophy that focuses on maximizing customer value while minimizing waste in all its forms. Rather than being confined to a set of technical tools, lean is fundamentally a strategic mindset that integrates continuous improvement into everyday operations. Core lean practices include 5S workplace organization systems, Value Stream Mapping for visualizing material and information flow, Just-in-Time approaches aimed at reducing inventory and lead times, and Kaizen initiatives that encourage sustained improvement across all organizational levels. Lean philosophy also classifies waste into several key categories, including overproduction, waiting time, unnecessary movement, excessive processing, transportation inefficiencies, inventory accumulation, product defects, and underutilization of human potential. Many of these forms of waste can be observed in Libyan industrial settings, often intensified by logistical instability, resource constraints, and traditional organizational structures.

2.1 Concept and Basic Tools

Lean manufacturing is a comprehensive management philosophy that aims to maximize customer value through the optimal use of resources and the continuous elimination of all forms of waste (Muda) [3]. It is not limited to technical tools but constitutes a transformative thinking methodology. Among its most prominent integrated tools are:

- 5S: A methodology for organizing and structuring the workplace.
- Value Stream Mapping (VSM): For analyzing and visualizing the flow of materials and information.
- Just-in-Time (JIT) Production: A system that aims to minimize inventory.
- Kaizen: A philosophy of continuous improvement that encompasses all organizational levels.

2.2 The Eight Types of Waste (Muda)

Lean manufacturing classifies waste into eight basic types, enabling organizations to identify and focus on the sources of loss, each of which can be observed clearly within the Libyan industrial context as summarized in Table (1).

Table(1) Types of Waste in Lean Manufacturing

Type of Waste	Description	Example in the Libyan Context
Overproduction	Producing more than required or before needed	Producing large quantities for government projects that may be delayed
Waiting	Delays due to machine downtime or material shortages	Waiting for raw material shipments due to import complexities
Unnecessary Transportation	Unjustified movement of materials or products	Temporary storage in multiple locations due to poor planning
Overprocessing	Performing more work than required by the customer	Conducting excessive quality tests due to a lack of confidence in standards
Excess Inventory	Storing more materials than necessary	Large stockpiling due to fear of supply disruptions
Unnecessary Movement	Worker movement that adds no value	Searching for tools due to poor workplace organization
Defects	Products requiring rework or disposal	High rejection rate in the food industry
Un-utilized Talent	Failure to utilize employee skills and creativity	Ignoring improvement suggestions from experienced workers

3. Research Methodology

- This study adopts a systematic review methodology designed to ensure transparency, rigor, and methodological reliability. A comprehensive search was conducted across internationally recognized academic databases such as Scopus, Web of Science, ScienceDirect, and Google Scholar, in addition to reputable regional and local journals. The search covered publications issued between 2010 and 2023, using carefully selected keywords related to lean manufacturing, industrial performance, continuous improvement, and contexts relevant to Libya or comparable developing countries.

- Clear inclusion and exclusion criteria were established to refine the search process. Only peer-reviewed empirical or review studies with methodological clarity and contextual relevance were retained, while non-academic publications and studies lacking scientific rigor were excluded. Titles, abstracts, and subsequently full texts were screened to ensure alignment with the study objectives.
- A qualitative thematic synthesis approach was then applied to extract key insights related to lean adoption levels, tools utilized, implementation challenges, enabling factors, and reported outcomes. Cross-study comparison facilitated the identification of recurring themes and critical gaps, forming the analytical basis for the contextual lean implementation framework proposed in this study.

3.1 Methodological Guidelines

A thorough review of previous studies reveals that adopting Lean methodologies in Libya requires a more integrated methodological framework. Recent reviews (Al-Kilidar & Al-Saadi, 2022; Dora et al., 2016) have called for the use of Lean maturity assessment tools before implementation, while Arab and local studies (Al-Fitouri, 2019; Alghariani, 2020) have emphasized the need to align improvement tools with the existing industrial infrastructure [16, 18, 20, 21]. Therefore, this paper offers the following methodological guidelines for researchers and practitioners:

- Employ hybrid methodologies combining VSM (Value Stream Mapping) and Time Studies.
- Conduct longitudinal studies instead of cross-sectional studies, as Lean implementation requires continuous monitoring.
- Conduct gap analysis to measure the current level compared to the target level.
- Employ local performance indicators that are relevant to the Libyan industry and do not rely solely on international standards.
- Utilize statistical analysis techniques such as ANOVA and correlation to analyze the impact of challenges on successful adoption.
- Document employee voices through semi-structured interviews, as organizational culture has a significant impact.
- Integrate Lean tools with Total Productive Maintenance (TPM) to enhance equipment efficiency in the Libyan work environment.
- Develop a priority matrix to identify the most applicable tools in Libya.

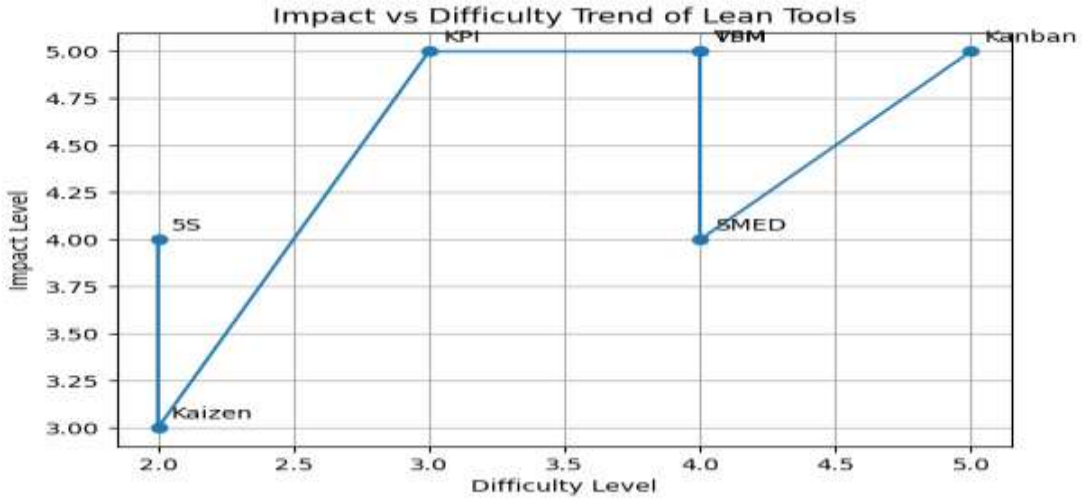
To support decision-making regarding tool selection, Table (2) presents an implementation priority matrix based on expected impact and implementation difficulty in the Libyan context.

Table(2) Impact vs. Difficulty of Lean Tools in the Libyan Context [9], [17]

Tool	Expected Impact on Performance (1=Low, 5=High)	Relative Implementation Difficulty in Libya (1=Low, 5=High)	Impact-to-Difficulty Ratio	Implementation Priority
5S	4	2	**2.00**	**Highest Priority (1)**
Kaizen Teams	3	2	**1.50**	**High (2)**
Waste-related KPIs	5	3	**1.67**	**High (3)**
Total Productive Maintenance (TPM)	5	4	**1.25**	**Medium (4)**
Value Stream Mapping (VSM)	5	4	**1.25**	**Medium (5)**
Single-Minute Exchange of Die (SMED)	4	4	**1.00**	**Medium (6)**
Kanban (JIT)	5	5	**1.00**	**Low/Later Stage (7)**

This table is created based on priority analysis principles and the "Lean Maturity Model" framework as discussed in [17], applied to the Libyan context as identified by previous studies [9, 12, 13].

Figure (1) provides a conceptual impact–difficulty curve that visually clarifies the positioning of Lean tools according to their expected performance benefits and relative implementation complexity in the Libyan context.



Figure(1) Conceptual Relationship Between Lean Tools Impact and Implementation Difficulty in the Libyan Context

Tools such as 5S, Kaizen, and waste-related KPIs appear in the high-impact and comparatively lower-difficulty zone, making them suitable for early-stage implementation. Conversely, tools such as Kanban and advanced JIT systems, although highly beneficial, fall within the high-difficulty range, suggesting that they are more appropriate for later stages of Lean maturity.

3.2 Data Analysis and Synthesis

- Given the heterogeneity of methodologies and the limited availability of quantitative datasets in the Libyan context, a qualitative thematic synthesis approach was employed. The selected studies were analyzed to identify recurring themes related to implementation barriers, enabling factors, tool adoption levels, and contextual constraints.
- The synthesis process emphasized pattern recognition and cross-study comparison, allowing the development of an integrated analytical framework that informed both the identification of challenges and the construction of the proposed implementation model.

4.Current Status of Lean Implementation in Libya

Findings from the reviewed literature indicate that lean manufacturing implementation in Libya remains uneven and largely context-dependent. Adoption levels vary across industrial sectors, with relatively greater engagement reported in oil and gas and selected food industries compared to construction and textile sectors. However, application is still primarily tool-based rather than representing a fully integrated lean transformation. Implementation is hindered by multiple interrelated barriers. Managerially, limited strategic commitment, centralized decision-making, and short-term performance orientations undermine sustained improvement initiatives. Technically, organizations face constraints related to skill shortages, insufficient training opportunities, and dependence on aging production systems. From a cultural standpoint, resistance to change, fear of accountability, and reliance on firefighting management practices continue to restrict the institutionalization of continuous improvement. These interacting constraints frequently result in superficial implementation efforts that fail to achieve long-term transformational impact.

4.1 Sectoral Adoption Levels

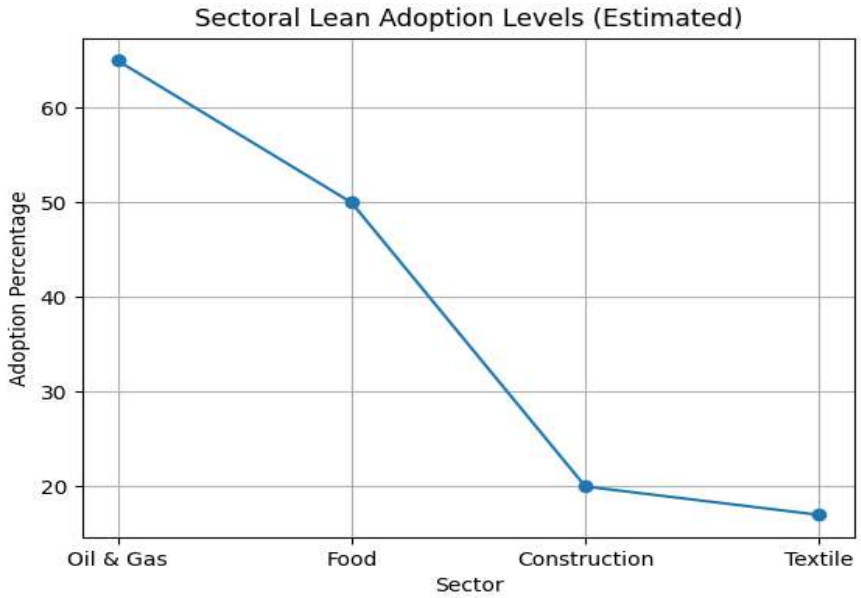
The literature indicates that the adoption of Lean manufacturing principles and tools in Libya is still in its initial and experimental stages, characterized by fragmentation and a lack of comprehensiveness. This partial adoption varies across major industrial sectors, being more prevalent in the oil and gas sector and some food industries compared to the construction and textile sectors.

The variation in lean tool adoption across industrial sectors is illustrated in Table 3, highlighting significant disparities between oil and gas, food, construction, and textile industries. The percentage estimates are derived from a synthesis of results from the cited local studies and align with the general pattern of uneven adoption across sectors in developing countries as noted in [7, 18].

Table(3) Comparative Adoption Rates of Lean Manufacturing Tools Among Libyan Industrial Sectors (Estimative based on analysis of local studies [11-15])

Tool / Practice	Oil & Gas Sector	Food & Beverage Sector	Construction Sector	Textile & Apparel Sector	Weighted Average
5S	Medium - High (70%)	Medium (60%)	Low (30%)	Very Low (20%)	**48%**
Value Stream Mapping (VSM)	High (80%)	Medium (50%)	Very Low (15%)	Low (25%)	**46%**
Total Productive Maintenance (TPM)	High (85%)	Medium - High (65%)	Low (35%)	Low (30%)	**56%**
Kanban (JIT)	Low (40%)	Very Low (25%)	Rare (5%)	Rare (5%)	**20%**
Kaizen (Improvement Teams)	Medium (55%)	Medium (60%)	Low (20%)	Very Low (15%)	**40%**
Single-Minute Exchange of Die (SMED)	Medium (50%)	Low (35%)	Rare (10%)	Rare (5%)	**27%**
Waste-related Key Performance Indicators (KPIs)	High (75%)	Medium (55%)	Low (25%)	Low (20%)	**46%**
Sectoral Adoption Average	**65%**	**50%**	**20%**	**17%**	**-**

To better illustrate the disparity in Lean adoption across different industrial sectors in Libya, Figure (2) presents an estimated comparative curve that highlights the significant variation in maturity levels among the sectors.



Figure(2) Estimated Sectoral Lean Adoption Levels in Libyan Industrial Sectors

This figure illustrates the estimated variation in Lean adoption levels across major Libyan industrial sectors. The results indicate that the Oil and Gas sector demonstrates the highest relative adoption, followed by the Food and Beverage sector, while both the Construction and Textile sectors lag significantly behind. This pattern reflects sectoral differences in technological readiness, managerial awareness, and operational stability.

4.2 Main Implementation Challenges

The literature review reveals a set of interconnected challenges hindering effective implementation, which can be categorized into three main areas.

The major barriers hindering effective lean implementation are categorized and summarized in Table (4).

Table (4) Main Challenges to Implementing Lean Manufacturing in Libya

Challenge Category	Specific Examples
Administrative and Organizational	Weak commitment from senior management, centralized hierarchical structures, ineffective performance measurement systems.
Technical and Human Resources	Skills gaps and lack of specialized training, limited support infrastructure, traditional quality systems.
Cultural and Environmental	Resistance to change, traditional organizational culture, environmental and economic instability.

The causal interactions among administrative, technical, and cultural challenges are illustrated in Figure(3)

Figure (3) Causal Relationship Model of Implementation Challenges in the Libyan Context

Model Adapted and developed from the "Root Cause Analysis" principle used in quality and continuous improvement literature [3, 9], applied to the Libyan context as discussed in [2, 8, 13].

These challenges interact with each other. For example, weak leadership (administrative) leads to insufficient investment in training (technical), which in turn reinforces resistance to change (cultural).

5. Implementation Framework

Based on a critical analysis of the challenges and opportunities, this paper presents a practical implementation framework comprised of four interconnected pillars, specifically designed for the Libyan context, as illustrated in Figure(4).

Figure (4) Four-Pillar Implementation Framework

- **Strategic Leadership and Commitment:** Ensuring support and a clear vision from the highest management level, and developing a strategic transformation plan.
- **Capacity Building and Competency Development:** Developing hierarchical and specialized training programs suitable for all levels, and investing in supporting infrastructure.
- **Contextual Adaptation and Flexibility:** Adapting lean manufacturing tools and practices to suit local conditions and the Libyan organizational culture, rather than importing ready-made models.
- **Performance Measurement and Evaluation Systems:** Developing smart Key Performance Indicators (KPIs) linked to improvement objectives, and establishing mechanisms for feedback and continuous learning.

Phase 1: Foundation & Readiness (6-12 Months)

├── Form a change leadership team with top management support.

├── Train leaders and supervisors on basic Lean concepts.

├── Implement a 5S program in a pilot production area/line.

└── Identify and measure basic waste-related KPIs in the pilot area.

Phase 2: Development & Expansion (12-24 Months)

├── Conduct Value Stream Mapping (VSM) for the pilot area.

├── Form and train Kaizen teams to solve specific problems.

├── Begin a Total Productive Maintenance (TPM) program for critical equipment.

└── Expand application and disseminate improvement culture to other departments.

Phase 3: Integration & Maturity (24-36 Months & Beyond)

├── Integrate Lean tools into a comprehensive management system.

├── Explore limited JIT application with reliable suppliers.

├── Link the continuous improvement program to strategic objectives.

└── Document and share lessons learned and successes internally and with other firms.

Figure (5) Proposed Phased Pathway for Lean Manufacturing Adoption in Libya.

The stepwise and phased adoption pathway is detailed in Figure(5) , aligning lean maturity with organizational readiness. Pathway developed based on "Lean Maturity Models" [16, 17] and the steps of Lean Thinking [1], adapted to the readiness and constraints of the Libyan industrial environment as revealed by this review [4, 5, 14]. This framework aims to provide a systematic and phased roadmap, starting with pilot projects in specific production units, then gradually expanding as experience accumulates and organizational trust is built.
To illustrate the expected organizational transformation trajectory, Figure (6) presents a conceptual Lean maturity progression curve that reflects how performance improvement and system stability are expected to evolve over time as Lean implementation moves from foundational readiness to full integration.

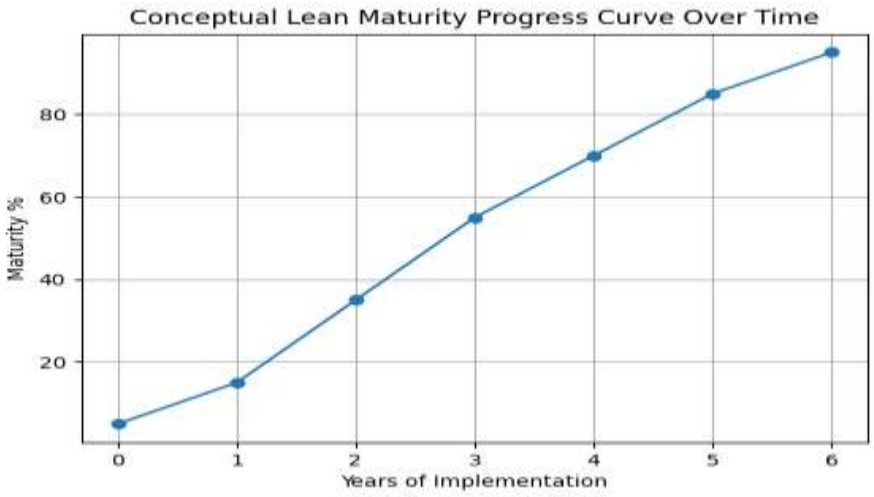


Figure (6) Proposed Lean Maturity Progression Curve for Libyan Industrial Enterprises

The curve demonstrates that initial phases typically yield modest improvements as organizations focus on awareness, stabilization, and foundational practices. However, once Lean principles become institutionalized and integrated into strategic and operational systems, performance improvements accelerate significantly, leading to sustainable high maturity levels. This reinforces the necessity of adopting a phased and long-term Lean implementation approach rather than expecting short-term transformational outcomes.

6. Conclusion

The synthesized literature indicates that lean manufacturing in Libya remains in its developmental phase, characterized by fragmented adoption and constrained by managerial, technical, and cultural barriers. Nevertheless, the current stage of national reconstruction presents a significant opportunity to modernize industrial operations and integrate continuous improvement principles into organizational practice. Realizing this opportunity requires a comprehensive, context-sensitive approach that aligns international best practices with Libyan industrial realities, fosters collaboration between industry and academia, and prioritizes capability development, long-term planning, and institutional learning.

7. Recommendations

- Initiate pilot projects in specific priority departments or production lines.
- Develop incentive systems linked to improvement outcomes and employee engagement.
- Conduct longitudinal and in-depth case studies within Libyan factories.
- Integrate lean manufacturing and continuous improvement concepts into national industrial development strategies.
- Provide tax and customs incentives to institutions that adopt modern improvement methodologies.
- Strengthening partnerships with international organizations (such as UNIDO) to transfer expertise and implement capacity-building programs [10].

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

8. References

[1] Womack, J. P., & Jones, D. T. (1996). Lean Thinking: Banish Waste and Create Wealth in Your Corporation. Simon & Schuster.

[2] El-Fergany, A. (2021). Challenges and opportunities for industrial development in post-conflict Libya. International Journal of Industrial Engineering and Management, 12 (3), 145-158.
[3] Liker, J. K. (2004). The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer. McGraw-Hill. https://www.mhprofessional.com/
[4] Al-Hasi, M., & Al-Ferjani, A. (2020). A mixed-method approach to investigate the lack of lean manufacturing implementation in Libyan industrial firms. Libyan Journal of Engineering Sciences and Technology, 8(2), 45–58.
[5] Al-Mabrouk, K. (2022). Optimizing efficiency: A comprehensive overview of lean manufacturing techniques and their impact on Libyan industry. Journal of Industrial Research and Development, 15(1), 22–35.
[6] Abdel-Maksoud, A., & El-Kholy, M. (2021). Lean application in the Egyptian glass industry: A case study on waste reduction and quality enhancement. Egyptian Journal of Industrial Engineering, 29 (2), 88–102.
[7] Bhasin, S. (2012). Prominent obstacles to lean. International Journal of Productivity and Performance Management, 61 (4), 403–425. https://doi.org/10.1108/17410401211212661
[8] Al-Khatib, A. W. (2020). Research gaps in lean manufacturing implementation in developing countries: A Libyan perspective. International Journal of Lean Six Sigma, 11(6), 1205–1222. https://doi.org/10.1108/IJLSS-02-2019-0016
[9] Achanga, P., Shehab, E., Roy, R., & Nelder, G. (2006). Critical success factors for lean implementation within SMEs. Journal of Manufacturing Technology Management, 17(4), 460–471. https://doi.org/10.1108/17410380610662889
[10] UNIDO. (2020). Industrial Development Report 2020: Industrializing in the Digital Age. United Nations Industrial Development Organization. https://www.unido.org/idr2020
[11] Al-Hassani, Mohamed, and Abdelsalam, Salem (2019). Evaluating the application of lean manufacturing principles in Libyan industrial companies -- a case study of the Libyan Iron and Steel Company. Journal of Engineering Sciences -- Misrata University, 8(2), 55–72.
[12] Al-Barghathi, Ahmed (2020). Obstacles to implementing continuous improvement systems in Libyan public sector factories. Journal of Engineering and Technology - Benghazi University, 13(1), 1–20.
[13] Al-Zarouq, Tayeb (2021). The Role of Organizational Culture in the Adoption of Lean Manufacturing in Libyan Textile Factories. Journal of Economic Sciences -- University of Sebha, 7 (3), 110–132.
[14] Jibril, Fayez (2022). Evaluating the Readiness of Libyan Industrial Enterprises to Implement Lean Six Sigma Methodologies. Journal of Industrial Research -- Industrial Research Center, Tripoli, 5 (1), 33–49.
[15] Al-Sharif, Khaled, and Al-Aqili, Yousef (2018). Measuring Losses in Production Lines Using Value Stream Maps -- A Study of a Beverage Factory in Libya. Journal of Industrial Engineering Applications, Omar Al-Mukhtar University, 4(1), 21–39.
[16] Al-Kilidar, H., & Al-Saadi, S. (2022). Lean manufacturing adoption in developing countries: A systematic review. Journal of Manufacturing Systems, 65, 142–159. https://doi.org/10.1016/j.jmsy.2022.09.009
[17] Pakdil, F., & Leonard, K. (2017). Criteria for a lean organization: Development of a lean assessment tool. International Journal of Production Research, 55(22), 7461–7478. https://doi.org/10.1080/00207543.2017.1349945
[18] Dora, M., Gellynck, X., & Van Goubergen, D. (2016). Lean practices in small and medium enterprises: lessons from developing countries. Production Planning & Control, 27(1), 1–13. https://doi.org/10.1080/09537287.2015.1062049
[19] Abdelhadi, A. (2021). Lean in the Middle East and North Africa: current state and future directions. Journal of Industrial Engineering and Management, 14(4), 100–115.
[20] Al-Fitouri, A. (2019). Quality challenges in Libyan industrial companies. Journal of Industrial Studies, 4(2), 90–105.
[21] Alghariani, S. (2020). Industrial performance assessment in Libyan manufacturing plants. Tripoli University Journal of Engineering Research, 12 (1), 55–68.
