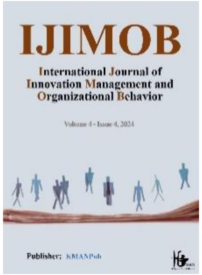
KMAN PUBLISHING INSTITUTE
Journal Website

Article history:
Received 06 April 2024
Revised 25 June 2024
Accepted 03 July 2024
Published online 01 October 2024

International Journal of Innovation Management and Organizational Behavior

Volume 4, Issue 4, pp 11-19



E-ISSN: 3041-8992

Design of a Lean Distribution Model in the Electric Power Industry with a World-Class Approach

Roxana. Radmaneshi[1], Farhad. Hadinejad[2*], Hassan. Farsijani[3]

[1] Department of Industrial Management, South Tehran Branch, Islamic Azad University, Tehran, Iran
[2] Assistant Professor, Department of Management, Faculty of Medicine, AJA University of Medical Sciences, Tehran, Iran
[3] Associate professor, Faculty of Management, Shahid Beheshti University, Tehran, Iran

*** Corresponding author email address**: HadinejadFarhad@gmail.com

A r t i c l e I n f o

Article type:
Original Research

How to cite this article:
Radmaneshi, R., Hadinejad, F., & Farsijani, H. (2024). Design of a Lean Distribution Model in the Electric Power Industry with a World-Class Approach. *International Journal of Innovation Management and Organizational Behavior*, *4*(4), 11-19.
https://doi.org/10.61838/kman.ijimob.4.4.2

A B S T R A C T

Objective: This study aims to design a lean distribution model tailored for the electric power distribution network in Tehran, integrating global best practices and expert insights to address the specific challenges and opportunities within this sector.

Methodology: The study employed a mixed-method approach, combining qualitative and quantitative techniques. A comprehensive literature review was conducted to identify key factors influencing lean distribution. Expert interviews with managers and industry specialists in Tehran's electric power distribution sector provided additional insights. The factors were structured and categorized using Interpretive Structural Modeling (ISM) and MicMac analysis to establish their interrelationships and influence.

Findings: The study identified 16 critical factors influencing lean distribution, with "World-Class Lean Distribution in the Electric Power Industry" emerging as the most influential. Other key factors included "Optimal Distribution of Reactive Power in Power Systems," "Estimation of Load Uncertainty," "Reduction of Loss Levels," and "Use of Fixed and Switchable Capacitors." The findings highlight the importance of infrastructure, ISO 9000 implementation, technological integration, internal capacity, and resilience.

Conclusion: The research provides a comprehensive framework for implementing lean distribution practices in the electric power industry, emphasizing the need for global standards, technological advancements, and resilience. The findings suggest that adopting these practices can lead to improved reliability, reduced operational costs, and enhanced customer satisfaction, contributing to sustainable development and energy security.

Keywords: *Lean Distribution, Electric Power Industry, Interpretive Structural Modeling, MicMac Analysis, Operational Efficiency, Sustainability*

1 Introduction

The application of lean principles has become a cornerstone for enhancing efficiency and performance across various industries. Originating from the Toyota Production System, lean methodology focuses on minimizing waste while maximizing value, leading to significant improvements in productivity and customer satisfaction (Stone, 2012). Over the past few decades, lean practices have evolved and adapted to fit different sectors, including manufacturing, healthcare, construction, and, more recently, the electric power industry (Danese et al., 2017; Maradzano et al., 2019).

The electric power industry, characterized by its complexity and critical nature, presents unique challenges and opportunities for the application of lean principles. The drive towards sustainability, reliability, and cost-efficiency in power distribution has necessitated the exploration of innovative management practices, including lean distribution models (Momenitabar et al., 2020)

Lean principles have demonstrated remarkable success in improving operational efficiencies in diverse sectors. In manufacturing, lean practices have led to significant reductions in production costs, cycle times, and defects, thereby enhancing overall competitiveness (Albliwi et al., 2015). The integration of lean and Six Sigma methodologies, commonly referred to as Lean Six Sigma, has further augmented these benefits by combining waste reduction with quality improvement (Narayanamurthy & Gurumurthy, 2016).

In the healthcare sector, lean principles have been instrumental in streamlining processes, reducing patient wait times, and improving service quality. Lean leadership attributes, such as commitment to continuous improvement and employee engagement, have been critical in driving these transformations (Albliwi et al., 2015). Similarly, in the construction industry, the adoption of lean principles has led to better project management, reduced material waste, and enhanced worker productivity (Maradzano et al., 2019).

The application of lean principles to the electric power industry is relatively nascent but holds significant promise. Power distribution networks are inherently complex, involving numerous stakeholders, intricate infrastructure, and stringent regulatory requirements. Lean distribution models can address these challenges by optimizing resource utilization, enhancing process efficiencies, and reducing operational costs (Ghaithan et al., 2023).

One critical aspect of lean distribution in the power industry is the optimization of voltage profiles and the mitigation of power losses. Nasir et al. (2022) highlighted the importance of optimizing distributed generation to improve voltage stability and reduce losses, aligning with lean objectives of waste reduction and efficiency (Nasir et al., 2022). Moreover, lean principles can facilitate the effective integration of renewable energy sources, thereby supporting sustainability goals and improving the overall resilience of the power grid (Momenitabar et al., 2020).

The theoretical foundations of this study are grounded in the principles of lean manufacturing and distribution, as well as the broader context of Industry 4.0 and circular economy frameworks. The convergence of these paradigms underscores the importance of a holistic approach to sustainability and efficiency in modern industrial practices (Ghaithan et al., 2023). By integrating these concepts, this study aims to develop a comprehensive lean distribution model that addresses the specific needs and challenges of the electric power industry in Tehran.

The significance of this study lies in its potential to contribute to the growing body of knowledge on lean applications in the power industry. While lean principles have been extensively studied and applied in manufacturing and healthcare, their application to power distribution remains underexplored (Zahraee, 2016). This study addresses this gap by providing a detailed analysis of lean distribution models tailored for the electric power industry, with a specific focus on the Tehran distribution network.

A comprehensive literature review was conducted to understand the current state of lean applications in various industries and identify best practices that could be adapted for the power distribution sector. Stone (2012) provided a historical overview of lean manufacturing, tracing its evolution over four decades and highlighting key milestones and adaptations. This foundational knowledge was instrumental in framing the study's approach to lean distribution (Stone, 2012). Danese et al. (2017) conducted a systematic literature review on recent lean research, identifying emerging trends and future directions. Their findings underscored the importance of integrating lean principles with modern technological advancements, such as Industry 4.0, to achieve greater efficiencies and sustainability (Danese et al., 2017). This perspective was echoed by Ghaithan et al. (2023), who explored the integrated impact of circular economy, Industry 4.0, and lean manufacturing on the sustainability performance of manufacturing firms (Ghaithan et al., 2023). Maradzano et

IJIMOB
E-ISSN: 3041-8992

al. (2019) examined the application of lean principles in the South African construction industry, demonstrating significant improvements in project management and resource utilization. These insights were valuable in understanding the potential benefits of lean practices in complex and dynamic environments, similar to those found in power distribution networks (Maradzano et al., 2019). In the context of the power industry, Momenitabar et al. (2020) proposed a lean distribution system for solar power plants using mathematical modeling and simulation techniques (Momenitabar et al., 2020). Their study provided a detailed methodology for optimizing distribution processes, which was adapted for this research. Nasir et al. (2022) further highlighted the importance of optimizing distributed generation to improve voltage profiles and reduce power losses, aligning with lean objectives of efficiency and waste reduction (Nasir et al., 2022).

Despite the extensive body of research on lean manufacturing and its applications, there is a notable gap in the literature concerning lean distribution in the power industry. Previous studies have primarily focused on manufacturing and construction, with limited exploration of power distribution networks (Osman et al., 2020; Yang et al., 2022; Zahraee, 2016). This study seeks to fill this gap by developing a lean distribution model specifically tailored for the electric power industry in Tehran.

The primary objectives of this research are:

- To identify and validate the critical factors influencing lean distribution in the electric power industry.
- To establish the interrelationships among these factors using ISM and MicMac analysis.
- To develop a comprehensive lean distribution model that can enhance the efficiency and sustainability of power distribution networks.

2 Methods and Materials

2.1 *Study Design and Participants*

This study employs a qualitative research design focused on the electric power distribution industry in Tehran. The primary participants in this study were managers and experts within the Tehran electric power distribution sector. A total of 16 key participants were selected based on their expertise and roles in the industry. These participants were engaged through in-depth face-to-face interviews to gather insights and identify critical factors influencing the lean distribution model.

2.2 *Data Collection*

Data collection involved several stages. Initially, a comprehensive literature review was conducted to establish a foundation for understanding lean distribution models and their application in the electric power industry. Following this, structured interviews were conducted with the selected participants. The interviews were designed to capture detailed information on the criteria influencing lean distribution and to obtain expert opinions on these factors.

To further structure the data, a questionnaire was developed based on the findings from the literature review and initial interviews. This questionnaire was distributed among the experts to validate the identified factors and gather quantitative data on the relationships between these factors. The experts were asked to score the influence of each factor on others using a scale from 0 to 4, where 0 indicated no influence, and 4 indicated a very strong influence.

2.3 *Data Analysis*

The data analysis was conducted using the Interpretive Structural Modeling (ISM) approach combined with the MicMac (Matrice d'Impacts Croisés Multiplication Appliquée à un Classement) method. This approach allowed for the structuring and categorization of the identified criteria and the establishment of relationships between them.

The ISM method involved the following steps:

Identification of Variables: Based on expert opinions, a list of critical variables influencing lean distribution was compiled.

Development of Structural Self-Interaction Matrix (SSIM): Experts scored the influence of each variable on every other variable, resulting in an initial SSIM.

Formation of the Reachability Matrix: The SSIM was converted into a binary reachability matrix, indicating direct relationships between variables.

Level Partitioning: The reachability matrix was then partitioned into different levels to form a hierarchical model, representing the interdependencies among the variables.

The MicMac method was used for structural analysis of the direct and indirect relationships among the variables:

Direct Influence Matrix Calculation: The initial scores from the SSIM were used to create a direct influence matrix, where each entry represented the direct influence of one variable on another.

Indirect Influence Calculation: Using matrix multiplication, the indirect influences were calculated to

IJIMOB
E-ISSN: 3041-8992

determine the overall influence of each variable on the others through intermediate variables.

Stability Check and Iteration: The process involved iterative calculations until stable values for direct and indirect influences were obtained, indicating the strength and presence of relationships between variables.

The final output of the MicMac analysis provided a comprehensive model illustrating the direct and indirect influences among the variables. This model was then used to identify key drivers and dependencies in the lean distribution system, enabling the formulation of strategies to enhance efficiency and performance in the electric power distribution industry.

In conclusion, the combined ISM and MicMac methods facilitated a robust analysis of the factors influencing lean distribution in Tehran's electric power industry, providing a structured framework for understanding and improving the system.

3 Findings and Results

Initially, 16 key factors influencing lean distribution in the electric power industry were identified through a comprehensive literature review and expert interviews. These factors were then validated and ranked by the experts using the MicMac analysis technique. The factors identified are as follows:

1. Infrastructure
2. Implementation of ISO 9000 in Distribution Companies
3. Location of Distributed Generation Resources in the Distribution Network
4. Improvement of Voltage Profile and Network Security
5. Minimizing Total Distribution Costs for Active Units
6. Speed of Lean Distribution in the Electric Power Industry
7. Ability to Resist Threatening Factors
8. Reliance on Internal Capacity
9. Cost
10. Identification of Control Variables to Minimize the Objective Function under System Constraints
11. Optimal Distribution of Reactive Power in Power Systems
12. Estimation of Load Uncertainty
13. Reduction of Loss Levels
14. Use of Fixed and Switchable Capacitors
15. Mechanism to Reduce Significant Losses Due to Reactive Power Consumption
16. World-Class Lean Distribution in the Electric Power Industry

The Direct Influence Matrix was calculated based on expert input. Table 1 shows the direct influence scores of each factor on every other factor.

Table 1

Direct Influence Matrix

	D01	D02	D03	D04	D05	D06	D07	D08	D09	D10	D11	D12	D13	D14	D15	D16
D01	0	3.5	3.5	3.25	3.5	3	4	3	4	3	4	4	4	4	3	3.75
D02	1	0	4	4	4	3	3.5	4	3.25	4	3.25	3	3.5	3.5	4	3.25
D03	1	4	0	3	4	3	4	3.75	3	4	3	4	3	4	4	4
D04	1	4	4	0	4	3	4	3.5	4	3.5	4	3	4	4	3	4
D05	1	1	1	1	0	3	3	4	3	3	3.75	4	4	3	3	3
D06	1	1	1	1	4	0	4	4	3.5	3	3.25	3	4	3	3	3
D07	1	1.25	1.75	1	1	1	0	3	3	4	4	4	4	3	4	3
D08	2	2	2	1	1	2	4	0	1.75	3.25	4	4	3	3	3	3.5
D09	2	1	1	2	2	1	1	1	0	1.25	4	3	3	3.75	4	3.75
D10	2	2	1	2	1	1	1	1	2	0	1	3	3	4	3.25	3.5
D11	2	1	1.25	2	1	1	2	2	2	4	0	3.25	4	3	4	3.5
D12	2	1	1	1	2	2	1	1	1	1	1	0	3.75	3.25	4	3.25
D13	1	1	2	1	2	1	1	1.5	1	2	1	3.5	0	4	3	4
D14	1	1.75	1.25	2	1	2	1	1	1	1	1	3.5	4	0	3	3
D15	1	2	1	1.25	2	1	1.5	1.5	1	1	1	1.75	1	2	0	2.25
D16	2	1	1	1	1	1	1	1.5	1.75	1.5	1	1	1	1	1	0

The normalized matrix as shown in Table 2 provides a clearer view of the relative influences of each factor.

IJIMOB
E-ISSN: 3041-8992

Table 2

Normalized Direct Influence Matrix

	D01	D02	D03	D04	D05	D06	D07	D08	D09	D10	D11	D12	D13	D14	D15	D16
D01	0.000	0.065	0.065	0.061	0.065	0.056	0.075	0.056	0.075	0.056	0.075	0.075	0.075	0.075	0.050	0.070
D02	0.019	0.000	0.075	0.075	0.075	0.056	0.065	0.075	0.061	0.075	0.061	0.056	0.065	0.065	0.075	0.061
D03	0.019	0.075	0.000	0.056	0.075	0.056	0.075	0.070	0.056	0.075	0.056	0.075	0.056	0.075	0.075	0.075
D04	0.019	0.075	0.075	0.000	0.075	0.056	0.075	0.065	0.075	0.065	0.075	0.056	0.075	0.075	0.056	0.075
D05	0.019	0.019	0.019	0.019	0.000	0.056	0.056	0.075	0.056	0.056	0.070	0.075	0.075	0.056	0.056	0.056
D06	0.019	0.019	0.019	0.019	0.075	0.000	0.075	0.075	0.065	0.056	0.061	0.056	0.075	0.056	0.056	0.056
D07	0.019	0.023	0.033	0.019	0.019	0.019	0.000	0.056	0.056	0.075	0.075	0.075	0.075	0.056	0.075	0.056
D08	0.037	0.037	0.037	0.019	0.019	0.037	0.075	0.000	0.033	0.061	0.075	0.075	0.056	0.056	0.056	0.065
D09	0.037	0.019	0.019	0.037	0.037	0.019	0.019	0.019	0.000	0.023	0.075	0.056	0.056	0.070	0.075	0.070
D10	0.037	0.037	0.019	0.037	0.019	0.019	0.019	0.019	0.037	0.000	0.019	0.056	0.056	0.075	0.061	0.065
D11	0.037	0.019	0.023	0.037	0.019	0.019	0.037	0.037	0.037	0.075	0.000	0.061	0.075	0.056	0.075	0.065
D12	0.037	0.019	0.019	0.019	0.037	0.037	0.019	0.019	0.019	0.019	0.019	0.000	0.070	0.061	0.075	0.061
D13	0.019	0.019	0.037	0.019	0.037	0.019	0.019	0.028	0.019	0.037	0.019	0.065	0.000	0.075	0.056	0.075
D14	0.019	0.033	0.023	0.037	0.019	0.037	0.019	0.019	0.019	0.019	0.019	0.065	0.075	0.000	0.056	0.056
D15	0.019	0.037	0.019	0.023	0.037	0.019	0.028	0.028	0.019	0.019	0.019	0.033	0.019	0.037	0.000	0.042
D16	0.037	0.019	0.019	0.019	0.019	0.019	0.019	0.028	0.033	0.028	0.019	0.019	0.019	0.019	0.019	0.000

The Complete Influence Matrix (Table 3) was derived by subtracting the normalized matrix from an identity matrix and then multiplying the result by the inverse of the normalized matrix. This matrix represents the overall influence of each factor, including direct and indirect effects.

Table 3

Complete Influence Matrix

SSIM	D01	D02	D03	D04	D05	D06	D07	D08	D09	D10	D11	D12	D13	D14	D15	D16
D01	0.075	0.151	0.149	0.145	0.169	0.145	0.182	0.167	0.182	0.180	0.194	0.229	0.232	0.230	0.218	0.236
D02	0.090	0.086	0.153	0.153	0.172	0.141	0.170	0.179	0.164	0.192	0.175	0.205	0.216	0.215	0.227	0.220
D03	0.090	0.155	0.082	0.135	0.171	0.140	0.177	0.174	0.159	0.191	0.170	0.220	0.207	0.221	0.226	0.231
D04	0.092	0.157	0.155	0.086	0.175	0.143	0.180	0.174	0.180	0.187	0.192	0.209	0.229	0.227	0.215	0.237
D05	0.074	0.080	0.079	0.079	0.074	0.117	0.132	0.150	0.131	0.143	0.153	0.185	0.187	0.169	0.173	0.176
D06	0.075	0.082	0.080	0.081	0.146	0.066	0.152	0.153	0.143	0.147	0.149	0.172	0.191	0.172	0.176	0.180
D07	0.071	0.083	0.089	0.077	0.088	0.078	0.072	0.126	0.126	0.155	0.150	0.178	0.179	0.163	0.184	0.170
D08	0.091	0.099	0.097	0.081	0.093	0.100	0.148	0.079	0.110	0.148	0.156	0.183	0.169	0.167	0.171	0.183
D09	0.082	0.072	0.070	0.088	0.099	0.073	0.083	0.084	0.065	0.096	0.141	0.147	0.149	0.161	0.168	0.168
D10	0.078	0.086	0.067	0.085	0.078	0.069	0.078	0.079	0.096	0.067	0.084	0.140	0.142	0.159	0.148	0.156
D11	0.085	0.076	0.078	0.091	0.085	0.075	0.104	0.105	0.105	0.148	0.074	0.157	0.172	0.155	0.174	0.171
D12	0.073	0.063	0.062	0.061	0.090	0.082	0.074	0.075	0.073	0.080	0.078	0.079	0.146	0.137	0.152	0.143
D13	0.057	0.064	0.079	0.062	0.090	0.066	0.074	0.083	0.073	0.098	0.078	0.142	0.081	0.151	0.136	0.157
D14	0.056	0.076	0.066	0.079	0.073	0.082	0.073	0.075	0.073	0.080	0.077	0.140	0.150	0.080	0.135	0.138
D15	0.049	0.072	0.054	0.058	0.079	0.056	0.073	0.074	0.064	0.070	0.069	0.096	0.084	0.100	0.066	0.139
D16	0.063	0.050	0.049	0.050	0.056	0.051	0.059	0.067	0.072	0.072	0.063	0.074	0.075	0.075	0.076	0.060

A threshold value of 0.123 was calculated to generate the Network Relationship Map (NRM), which only includes significant relationships. All values in the Complete Influence Matrix below (Table 4) this threshold were set to zero.

E-ISSN: 3041-8992

Table 4

Network Relationship Map

SSIM	D01	D02	D03	D04	D05	D06	D07	D08	D10	D11	D12	D13	D14	D15	D16
D01	X	0.151	0.149	0.145	0.169	0.145	0.182	0.167	0.180	0.194	0.229	0.232	0.230	0.218	0.236
D02	X	X	0.153	0.153	0.172	0.141	0.170	0.179	0.192	0.175	0.205	0.216	0.215	0.227	0.220
D03	X	0.155	X	0.135	0.171	0.140	0.177	0.174	0.191	0.170	0.220	0.207	0.221	0.226	0.231
D04	X	0.157	0.155	X	0.175	0.143	0.180	0.174	0.187	0.192	0.209	0.229	0.227	0.215	0.237
D05	X	X	X	X	X	X	0.132	0.150	0.143	0.153	0.185	0.187	0.169	0.173	0.176
D06	X	X	X	X	0.146	X	0.152	0.153	0.147	0.149	0.172	0.191	0.172	0.176	0.180
D07	X	X	X	X	X	X	X	0.126	0.155	0.150	0.178	0.179	0.163	0.184	0.170
D08	X	X	X	X	X	X	0.148	X	0.148	0.156	0.183	0.169	0.167	0.171	0.183
D09	X	X	X	X	X	X	X	X	X	0.141	0.147	0.149	0.161	0.168	0.168
D10	X	X	X	X	X	X	X	X	X	X	0.140	0.142	0.159	0.148	0.156
D11	X	X	X	X	X	X	X	X	0.148	X	0.157	0.172	0.155	0.174	0.171
D12	X	X	X	X	X	X	X	X	X	X	X	0.146	0.137	0.152	0.143
D13	X	X	X	X	X	X	X	X	X	X	0.142	X	0.151	0.136	0.157
D14	X	X	X	X	X	X	X	X	X	X	0.140	0.150	X	0.135	0.138
D15	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0.139
D16	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

The matrix analysis indicated that "World-Class Lean Distribution in the Electric Power Industry" (D16) is the most influential factor, positioned at the highest level. Following this, the factors "Optimal Distribution of Reactive Power in Power Systems" (D11), "Estimation of Load Uncertainty" (D12), "Reduction of Loss Levels" (D13), and "Use of Fixed and Switchable Capacitors" (D14) were identified at the second level (Table 5).

Table 5

Levels of Variables

Level	Variables
1	D16 - World-Class Lean Distribution in the Electric Power Industry
2	D11 - Optimal Distribution of Reactive Power in Power Systems, D12 - Estimation of Load Uncertainty
	D13 - Reduction of Loss Levels, D14 - Use of Fixed and Switchable Capacitors
3	D05, D06, D07, D08, D09, D10
4	D01, D02, D03, D04

The final structural model demonstrates the hierarchical relationships and dependencies among the identified factors. The model indicates the levels and significant interrelationships among the factors, essential for achieving a world-class lean distribution system in the electric power industry.

In summary, this study has identified critical factors and established their interrelationships through rigorous ISM and MicMac analysis. These findings provide a robust framework for enhancing lean distribution practices in the electric power industry, with a clear roadmap for implementing world-class standards.

4 Discussion and Conclusion

This study aimed to design a lean distribution model tailored for the electric power industry in Tehran, employing Interpretive Structural Modeling (ISM) and MicMac analysis. The research identified 16 critical factors influencing lean distribution, with "World-Class Lean Distribution in the Electric Power Industry" (D16) emerging as the most influential. Other key factors included "Optimal Distribution of Reactive Power in Power Systems" (D11), "Estimation of Load Uncertainty" (D12), "Reduction of Loss Levels" (D13), and "Use of Fixed and Switchable Capacitors" (D14). The study highlighted the importance of infrastructure, implementation of ISO 9000 standards, technological integration, internal capacity, and resilience in achieving lean distribution.

The most influential factor identified is "World-Class Lean Distribution in the Electric Power Industry" (D16), which underscores the importance of adopting global best practices and standards. This factor's positioning at the highest level in our model indicates its overarching impact

IJIMOB
E-ISSN: 3041-8992

on other variables. It aligns with the broader trend in industrial management where global benchmarking and the adoption of best practices are crucial for achieving operational excellence (Danese et al., 2017).

Following D16, factors such as "Optimal Distribution of Reactive Power in Power Systems" (D11), "Estimation of Load Uncertainty" (D12), "Reduction of Loss Levels" (D13), and "Use of Fixed and Switchable Capacitors" (D14) were identified as the second level of influence. These factors are essential for maintaining stability and efficiency in power distribution networks. Nasir et al. (2022) highlighted similar factors, emphasizing the role of optimizing distributed generation to improve voltage profiles and reduce power losses, which directly correlates with our findings (Nasir et al., 2022).

The identification of infrastructure (D01) and implementation of ISO 9000 standards (D02) as significant factors reflects the importance of foundational elements in achieving lean distribution. Zahraee (2016) noted that the implementation of quality management systems like ISO 9000 is a critical step in lean manufacturing, providing a structured approach to continuous improvement and waste reduction (Zahraee, 2016). This finding supports the notion that a robust infrastructure and adherence to quality standards are prerequisites for effective lean distribution.

The integration of advanced technologies and Industry 4.0 principles (D03) also emerged as a crucial factor. Ghaithan et al. (2023) discussed the synergistic effects of combining circular economy, Industry 4.0, and lean manufacturing on sustainability performance (Ghaithan et al., 2023). Our study corroborates this by highlighting the significant role that technological advancements play in optimizing power distribution processes. The use of technologies for better location of distributed generation resources and improving network security can lead to substantial efficiency gains.

One of the key insights from our study is the role of internal capacity and resilience (D07, D08) in lean distribution. These factors indicate that the ability to withstand external threats and the reliance on internal resources are critical for maintaining operational stability. This aligns with the findings of Maradzano et al. (2019), who emphasized the importance of resilience and resource optimization in the construction industry, suggesting a parallel in the power industry where resilience to disruptions can significantly enhance performance (Maradzano et al., 2019).

The alignment of our findings with previous studies underscores the validity and relevance of our research. For instance, the emphasis on reducing power losses and optimizing voltage profiles is consistent with the work of Nasir et al. (2022), who demonstrated that optimizing distributed generation could lead to substantial improvements in power quality and efficiency (Nasir et al., 2022).

Furthermore, the role of lean leadership in driving these transformations cannot be overstated. Aij and Teunissen (2017) highlighted the importance of leadership attributes such as commitment to continuous improvement and employee engagement in achieving lean objectives (Aij & Teunissen, 2017). Our study supports this by identifying the need for strong leadership to implement and sustain lean practices in the power industry.

The holistic approach to lean distribution, integrating principles from lean manufacturing, Industry 4.0, and sustainability frameworks, reflects the evolving nature of lean practices. Ghaithan et al. (2023) and Dorval et al. (2019) both emphasized the need for an integrated approach to achieve comprehensive and sustainable improvements in industrial operations (Dorval et al., 2019; Ghaithan et al., 2023). Our findings align with this perspective, suggesting that a multi-faceted approach is essential for effective lean distribution in the power industry.

The findings of this study underscore the potential of lean principles to significantly enhance the efficiency and sustainability of power distribution networks. By identifying and structuring the critical factors influencing lean distribution, this research provides a comprehensive framework that power distribution companies can use to optimize their operations. The emphasis on global best practices, technological advancements, and resilience aligns with contemporary trends in industrial management, offering a roadmap for achieving world-class performance standards in the electric power industry. Implementing these lean practices can lead to improved reliability, reduced operational costs, and enhanced customer satisfaction, ultimately contributing to broader goals of sustainable development and energy security.

While this study offers valuable insights into lean distribution in the electric power industry, it is not without limitations. The research is primarily based on expert opinions and data collected from the Tehran distribution network, which may limit the generalizability of the findings to other regions or contexts. Additionally, the dynamic nature of the electric power industry means that new factors may emerge over time, necessitating ongoing research and adaptation of the lean distribution model.

Future research should focus on validating the findings of this study in different geographical and operational contexts to enhance the generalizability of the lean distribution model. Longitudinal studies could provide deeper insights into the long-term impacts of lean distribution practices on operational performance and sustainability. Additionally, exploring the integration of emerging technologies such as artificial intelligence and machine learning in lean distribution models could offer new avenues for optimizing power distribution networks.

For practitioners in the electric power industry, this study provides a practical framework for implementing lean distribution practices. Companies should prioritize the adoption of global standards, invest in technological integration, and develop robust infrastructure and resilience strategies. Training and development programs focused on lean principles and quality management can further support these efforts. By leveraging the comprehensive model developed in this research, power distribution companies can enhance their operational efficiencies, reduce costs, and improve service quality, contributing to the overall sustainability and reliability of the power grid.

Authors' Contributions

All authors have contributed significantly to the research process and the development of the manuscript.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

Acknowledgments

We would like to express our gratitude to all individuals helped us to do the project.

Declaration of Interest

The authors report no conflict of interest.

Funding

According to the authors, this article has no financial support.

Ethical Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were observed.

References

Aij, K. H., & Teunissen, M. (2017). Lean Leadership Attributes: A Systematic Review of the Literature. *Journal of Health Organization and Management*, *31*(7/8), 713-729. https://doi.org/10.1108/jhom-12-2016-0245

Albliwi, S. A., Antony, J., & Lim, S. A. H. (2015). A Systematic Review of Lean Six Sigma for the Manufacturing Industry. *Business Process Management Journal*, *21*(3), 665-691. https://doi.org/10.1108/bpmj-03-2014-0019

Danese, P., Manfè, V., & Romano, P. (2017). A Systematic Literature Review on Recent Lean Research: State-of-the-art and Future Directions. *International Journal of Management Reviews*, *20*(2), 579-605. https://doi.org/10.1111/ijmr.12156

Dorval, M., Jobin, M. H., & Benomar, N. (2019). Lean Culture: A Comprehensive Systematic Literature Review. *International Journal of Productivity and Performance Management*, *68*(5), 920-937. https://doi.org/10.1108/ijppm-03-2018-0087

Ghaithan, A. M., Alshammakhi, Y., Mohammed, A., & Mazher, K. M. (2023). Integrated Impact of Circular Economy, Industry 4.0, and Lean Manufacturing on Sustainability Performance of Manufacturing Firms. *International journal of environmental research and public health*, *20*(6), 5119. https://doi.org/10.3390/ijerph20065119

Maradzano, I., Matope, S., & Dondofema, R. A. (2019). Application of Lean Principles in the South African Construction Industry. *The South African Journal of Industrial Engineering*, *30*(3). https://doi.org/10.7166/30-3-2240

Momenitabar, M., Ebrahimi, Z. D., Hosseini, S. H., & Arani, M. (2020). A Proposed Lean Distribution System for Solar Power Plants Using Mathematical Modeling and Simulation Technique. https://doi.org/10.1109/dasa51403.2020.9317257

Narayanamurthy, G., & Gurumurthy, A. (2016). Leanness Assessment: A Literature Review. *International Journal of Operations & Production Management*, *36*(10), 1115-1160. https://doi.org/10.1108/ijopm-01-2015-0003

Nasir, S. N. S., Othman, A. F., Ayop, R., & Jamian, J. J. (2022). Power Loss Mitigation and Voltage Profile Improvement by Optimizing Distributed Generation. *Journal of Physics Conference Series*, *2312*(1), 012023. https://doi.org/10.1088/1742-6596/2312/1/012023

Osman, A. A., Othman, A. A., & Mohd Kamarul Irwan Abdul, R. (2020). Lean Manufacturing Adoption in Malaysia: A Systematic Literature Review. *Ijscol*, *1*(1), 01-35. https://doi.org/10.35631/ijscol.11001

Stone, K. B. (2012). Four Decades of Lean: A Systematic Literature Review. *International Journal of Lean Six Sigma*, *3*(2), 112-132. https://doi.org/10.1108/20401461211243702

Yang, Q., Yin, S., Li, Q., & Li, Y. (2022). Analysis of Electricity Consumption Behaviors Based on Principal Component Analysis and Density Peak Clustering. *Concurrency and*

IJIMOB E-ISSN: 3041-8992

Computation Practice and Experience, *34*(21). https://doi.org/10.1002/cpe.7126

Zahraee, S. M. (2016). A Survey on Lean Manufacturing Implementation in a Selected Manufacturing Industry in Iran. *International Journal of Lean Six Sigma*, *7*(2), 136-148. https://doi.org/10.1108/ijlss-03-2015-0010

IJIMOB
E-ISSN: 3041-8992