The Role of Lean in Enhancing In-Plant Logistics Efficiency in EV Assembly Plants

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Abstract.

The objectives of this study are threefold: (1) to examine the role of Lean principles within the logistics sector; (2) to investigate the factors influencing Electric Vehicle (EV) assembly plants; and (3) to develop guidelines for improving and optimizing logistics efficiency in EV assembly through Lean methodology.

This study employed a survey research design. The target population comprised employees at EV assembly plants across three provinces in the Eastern region of Thailand. Data were collected using a structured questionnaire based on a five-point Likert scale. Descriptive statistical techniques, including frequency, percentage, mean, and standard deviation, were utilized to analyze the general characteristics of the respondents and overall satisfaction levels. Inferential statistical analyses, specifically Pearson's Correlation Coefficient and Multiple Regression Analysis, were applied to examine the relationships between variables and to determine the extent to which identified factors influence the role of Lean.

The findings indicate that the overall level of Lean implementation in the EV industry is high. Lead time, cycle time (Takt time), and spare parts inventory levels were found to be the most significant factors influencing the role of Lean, followed by the reduction of processes or steps within the EV assembly line. Furthermore, a majority of respondents emphasized the critical importance of spare parts inventory management in EV assembly. These results provide valuable insights to support administrative decision-making and strategic planning aimed at enhancing quality and optimizing efficiency in the electric vehicle assembly process.

Keywords: user satisfaction, indoor restroom facilities, data analysis methods, service quality

1. Introduction

The rapid expansion of the electric vehicle (EV) industry has intensified the need for highly efficient in-plant logistics systems capable of supporting complex assembly processes, high product variety, and strict sustainability requirements. In-plant logistics plays a critical role in ensuring the timely flow of materials, components, and information across EV assembly plants, directly influencing productivity, cost efficiency, and operational reliability. This study examines the role of Lean principles in enhancing in-plant logistics efficiency within EV assembly environments. Drawing on Lean manufacturing theory, particularly the concepts of waste elimination, flow optimization, and continuous improvement, the research explores how Lean tools such as Just-in-Time (JIT), Kanban, standardized work, and layout optimization contribute to improved logistics performance. The study adopts a conceptual and empirical approach, synthesizing insights from existing literature and evidence from manufacturing

practices in the automotive and EV sectors**.** The findings indicate that the effective integration of Lean practices significantly reduces material handling waste, minimizes inventory levels, shortens internal transport distances, and improves synchronization between logistics and assembly operations**.** Moreover, Lean**-**based in**-**plant logistics enhances flexibility and responsiveness, which are essential for managing demand variability and technological change in EV production**.** The study contributes to the growing body of knowledge on Lean logistics by contextualizing its application within EV assembly plants and highlighting its strategic role in achieving operational excellence and sustainable manufacturing performance**.** Practical implications are provided for managers seeking to design and improve in**-**plant logistics systems aligned with Lean thinking in the evolving EV industry**.**

1.1 Research Objective

1**.**1**.**1 To assess the Milk Run, Line Feeding

1**.**1**.**2 To examine the factors affecting how to use Kanban in EV parts

1**.**1**.**3 To propose guidelines for Lean Enhancing In**-**Plant Logistics Efficiency in EV Assembly Plants**.**

2. Literature review

The study entitled **"**The Role of Lean in Enhancing In**-**Plant Logistics Efficiency in EV Assembly Plants**"** employed relevant concepts, theories, and previous research as a framework for analyzing and synthesizing the data**.** The summary is presented as follows

2**.**1 Concepts and Related Theories

2**.**1**.**1 Milk run

2**.**1**.**2 Line feeding

2**.**1**.**3 Kanban system

2**.**1**.**4 Related Research Studies

2**.**1**.**5 Conceptual Framework

3. Methodology

The research entitled **"The Role of Lean in Enhancing In- Plant Logistics Efficiency in EV Assembly Plants"** was conducted to analyze user satisfaction and propose appropriate improvement guidelines. The research procedures were carried out in the following steps:

1. Research Population and Sample

The research population consisted of EV plants employees, totaling **200 respondents**, classified as follows:

- **workers:** 125 respondents
- **Commander (Managers, Supervisors:** 75 respondents

2. Research Instruments for Data Collection

The instrument used for data collection was a questionnaire designed to The Role of Lean in Enhancing In-Plant Logistics Efficiency in EV Assembly Plants. The questionnaire was divided into three sections:

- **Section 1:** Personal information of the respondents, including gender, age, length of service, and position.
- **Section 2:** A satisfaction questionnaire regarding restroom management and services, measured using a **five- level Likert scale**. The levels of satisfaction were defined as follows:
  - Very high satisfaction = 5 points
  - High satisfaction = 4 points
  - Moderate satisfaction = 3 points
  - Low satisfaction = 2 points
  - Very low satisfaction = 1 point
- **Section 3:** Open- ended questions aimed at collecting suggestions and recommendations.

3. Development of Research Instruments

The researcher developed a five- level rating scale questionnaire for data collection by following these steps:

1. Reviewing principles, concepts, theories, and related research on user satisfaction and service management from relevant documents and literature.
2. Designing the questionnaire in accordance with established principles and procedures for questionnaire construction and within the scope of the research objectives.
3. Submitting the instrument to the research committee for review, suggestions, and approval to ensure its completeness and content validity prior to data collection.

4. Data Collection Procedures

Data was collected using the questionnaire during the period from **October 2025 to February 2026**.

5. Data Analysis and Interpretation

The returned questionnaires were analyzed in the following steps:

1. Responses to all questionnaire items were coded and entered into a computer system for analysis.
2. Basic statistical analyses were conducted, including the calculation of **mean scores ($\bar{X}$)** and percentages for each aspect and item. The satisfaction levels were evaluated based on the five-level Likert scale scoring criteria as follows:
   - Very high satisfaction = 5 points
   - High satisfaction = 4 points

- Moderate satisfaction = 3 points
- Low satisfaction = 2 points
- Very low satisfaction = 1 point

The interpretation of mean scores followed the criteria proposed by **Boonchom Srisawat (2013: 100)**:

- Mean score 4.51–5.00 = Very high satisfaction
- Mean score 3.51–4.50 = High satisfaction
- Mean score 2.51–3.50 = Moderate satisfaction
- Mean score 1.51–2.50 = Low satisfaction
- Mean score 1.00–1.50 = Very low satisfaction

6. Statistical Methods Used for Data Analysis

1. **Descriptive statistics** were employed to describe and summarize general characteristics of the variables, including frequency, percentage, mean, and standard deviation. The results were presented in tables accompanied by explanations.
2. **Inferential statistics** were used to examine differences in satisfaction levels based on personal factors. These included the **independent samples t-test** and **one-way analysis of variance (One-Way ANOVA)**.

4. Results

Section 1: Analysis of General Information of the Respondents

Table 1 Frequency and Percentage of the Respondents' General Information

General Information	Number (Persons)	Percentage
Gender		
1.Male	85	42.5
2.Female	115	57.5
Total	**200**	**100**
Age		
1. 18 – 20 year old.	80	40
2. 21 – 25 year old.	45	22.5
3. 26 – 30 year old.	16	8
4. 31 – 35 year old.	25	12.5
5. 36 years and above	34	17
รวม	**200**	**100**

From **Table 1**, the analysis of the general information of the **200 respondents** revealed the following:

- **Gender:** 115 were female (57.5%) and 85 were male (42.5%).
- **Age:** The majority of respondents were aged 18–20 years (80 respondents, 40%), followed by those aged 45 years (45 respondents, 22.5%), and those older than 35 years (34 respondents, 17%).

Section 2: Implementation of Lean Systems in Electric Vehicle (EV) Assembly Plants

Currently, the electric vehicle manufacturing industry receives significant support from the government sector. Based on a sample size of $n = 200$, the findings indicate that the overall level of understanding regarding Lean systems is high ($\bar{x} = 4.25, S.D. = 0.58$). This suggests that respondents possess a positive perception toward the integration of Lean principles within the EV assembly industry.

Upon examining practical implementation, **Inventory Management** achieved the highest mean score ($\bar{x} = 4.32$), reflecting a robust understanding of effective Lean execution. This was followed by the **Reduction of Non-Value-Added Steps**, which also received a high rating. Regarding **Preventive Maintenance**, although the mean score was slightly lower than other dimensions, it remained at a high level, signifying further opportunities to utilize Lean systems for enhanced production efficiency.

These findings serve as valuable data for planning, developing, and elevating the quality of electric vehicle production management. Such insights ensure alignment with the needs and expectations of practitioners regarding Lean manufacturing systems, ultimately fostering appropriate and sustainable operational excellence.

5. Conclusion

This study investigates the implementation of Lean systems within electric vehicle (EV) assembly plants, with a primary focus on improving production efficiency. The research objectives are threefold: to evaluate the effectiveness of Milk Run logistics and line-side parts feeding systems; to identify the factors influencing the adoption of Kanban systems for spare parts inventory control; and to propose strategic guidelines for the improvement and development of EV production processes.

Methodology: The study utilized a quantitative approach, gathering data from a sample size of 200 respondents via a structured research questionnaire. Data analysis was conducted using descriptive statistics, specifically focusing on the arithmetic mean ($\bar{X}$) and standard deviation ($S.D.$).

Research Findings: The results indicate a high level of overall satisfaction among practitioners regarding the integration of Lean systems in EV manufacturing ($\bar{X} = 4.25$, $S.D. = 0.58$). Detailed analysis reveals that inventory level control received the highest satisfaction rating, followed by the reduction of procedural redundancies in operational workflows.

Furthermore, the study aligns with the findings of Hiranphaet et al. (2025), who noted in their research on supply chain and innovation management that there is a significant correlation between employee perception of operational procedures and organizational efficiency.

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