

A Qualitative Assessment of Material Handling System Improvements in Engineering Industries

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Abstract: *Material handling systems play a critical role in influencing productivity, safety, quality, and operational cost in engineering industries. However, they are often treated as support functions rather than strategic enablers. This study presents a qualitative assessment of material handling system improvements based on open-ended survey responses from 53 engineers working across different mechanical engineering industries. The objective is to capture practitioner-driven improvement suggestions derived from real shop-floor experience. Qualitative thematic analysis was used to classify the responses into key improvement areas, including material-specific handling strategies, safety integration through engineering and administrative controls, reduction of Cost of Poor Quality (COPQ), layout optimization, waste elimination, maintenance practices, and automation. The findings indicate a strong consensus on the need to customize material handling systems according to material characteristics, optimize space utilization, reduce manual handling, and recognize material handling as a separate operational pillar alongside production and quality. The study provides practical insights that can assist engineering industries in enhancing safety performance, cost competitiveness, and overall operational effectiveness.*

Keywords: Material Handling System, Engineering Industries, Qualitative Assessment

I. INTRODUCTION

Material handling systems constitute a fundamental component of manufacturing and engineering operations, encompassing the movement, storage, control, and protection of materials throughout the production cycle. In engineering industries, material handling activities occur at every stage—from raw material receipt and storage to machining, assembly, inspection, and final dispatch. Although these activities do not directly add value to the product, they significantly influence productivity, cost, safety, quality, and overall operational efficiency.

Studies indicate that material handling accounts for a substantial proportion of manufacturing cost and time. Inefficient handling practices lead to excessive material movement, congestion, increased cycle time, and higher probability of damage and rework. In addition, unsafe handling conditions contribute to occupational injuries, equipment failure, and unplanned downtime. Despite these impacts, material handling is often perceived as a secondary or support function, receiving limited attention compared to production and quality functions.

The increasing diversity of materials used in engineering industries further complicates material handling operations. Components may range from small and lightweight items such as fasteners and washers to large and heavy assemblies or fabricated panels weighing several hundred kilograms. Such variation necessitates customized handling strategies, appropriate equipment selection, and careful layout planning. A standardized approach to material handling is therefore insufficient to address the operational complexities of modern engineering environments.

In the current industrial landscape, characterized by high production volumes, cost competitiveness, and stringent quality requirements, the role of material handling has become more critical than ever. Inefficient material handling directly contributes to the Cost of Poor Quality (COPQ) through material damage, improper storage, excessive manual handling, and delays. Furthermore, increased emphasis on workplace safety and regulatory compliance demands systematic integration of engineering and administrative controls in material handling systems.



While existing literature extensively discusses quantitative optimization models, automation technologies, and layout design techniques, there is limited focus on capturing the experiential insights of practicing engineers who interact daily with material handling systems. Practitioner-driven perspectives are essential for understanding practical challenges, implementation barriers, and improvement opportunities that may not be evident through theoretical models alone.

In this context, the present study aims to provide a qualitative assessment of material handling system improvements in engineering industries based on open-ended responses from practicing engineers. By analyzing insights from 53 engineers working in diverse mechanical engineering sectors, the study seeks to identify recurring themes related to safety, cost, layout, waste elimination, maintenance, and automation. The findings are intended to support industry practitioners and decision-makers in recognizing material handling as a strategic operational pillar and in developing more effective, safe, and cost-efficient material handling systems.

II. LITERATURE REVIEW

Previous studies highlight that material handling can account for 20–30% of total manufacturing cost in industrial operations. Apple (1990) emphasized systematic material handling design as a critical factor in improving productivity. Tompkins et al. (2010) identified facility layout and material flow as major contributors to operational efficiency. Groover (2016) discussed the role of automation in reducing manual handling and improving consistency. Lean manufacturing literature classifies unnecessary movement as a non-value-added activity that should be minimized. However, most existing studies focus on quantitative optimization models, with limited emphasis on practitioner-driven qualitative insights.

This research addresses this gap by presenting improvement suggestions derived directly from engineers actively involved in material handling and shop-floor operations.

III. RESEARCH METHODOLOGY

3.1 Research Design

A qualitative research design was adopted to capture experiential insights related to material handling system improvements. Data was collected through a questionnaire-based survey consisting primarily of open-ended questions. The present study adopts a qualitative research design to explore improvement opportunities in material handling systems within engineering industries. A qualitative approach was selected to capture detailed, experience-based insights from practicing engineers, which are often difficult to obtain through purely quantitative methods. The study focuses on understanding perceptions, challenges, and recommendations related to material handling practices rather than measuring predefined performance variables.

3.2 Survey Sample

The survey was conducted among 53 engineers working in different mechanical engineering industries, including manufacturing, fabrication, assembly, and heavy engineering sectors. Respondents included production, quality, maintenance, and industrial engineers with direct exposure to material handling systems.

3.3 Data Collection

The questionnaire invited respondents to share:

- Challenges in existing material handling systems
- Safety concerns during material movement
- Impact of material handling on cost and quality
- Suggestions for layout, automation, and maintenance improvements

3.4 Data Analysis

Responses were analyzed using thematic analysis. Recurrent ideas and patterns were grouped into key improvement themes. These themes form the basis of the findings discussed in this paper.



IV. FINDINGS AND QUALITATIVE ANALYSIS

4.1 Material-Specific Handling Strategies

Respondents emphasized that material handling practices should be based on material size, weight, and type. Handling requirements differ significantly between small components such as washers and heavy components exceeding 1000 kg. Engineers highlighted the need for customized handling solutions rather than uniform systems.

4.2 Safety Integration in Material Handling

Safety emerged as a dominant theme. Engineers stressed mandatory use of personal protective equipment (PPE) during material movement. However, they also emphasized that PPE alone is insufficient and should be supported by engineering controls (automation, guards) and administrative controls (procedures, training).

4.3 Material Handling and Cost of Poor Quality

A strong consensus was observed regarding the contribution of inefficient material handling to the Cost of Poor Quality (COPQ). Engineers reported frequent material damage, rework, and delays caused by improper handling and storage. Improving material handling was viewed as a direct means to reduce operational cost.

4.4 Layout Optimization and Space Utilization

Many respondents indicated that inadequate space allocation leads to congestion, unsafe movement, and excessive handling. Suggested improvements included atomized layouts, defined material flow paths, and better utilization of vertical space using racks and structured storage systems.

4.5 Waste Elimination in Material Movement

Unnecessary material movement was identified as a major form of waste. Engineers recommended placing materials at the right location and using appropriate material handling equipment to eliminate repeated handling and transportation.

4.6 Maintenance and Organizational Priority

Respondents highlighted the importance of timely maintenance of material handling equipment. Several engineers suggested forming a dedicated material handling team and treating material handling as a separate operational pillar, similar to production and quality departments.

4.7 Automation and Ergonomics

Reducing manual handling was widely recommended to improve quality consistency and reduce ergonomic risks. However, respondents emphasized that automation solutions should be user-friendly, economically viable, and suitable for industry conditions.

The qualitative findings indicate that practicing engineers recognize material handling as a strategic function influencing safety, cost, and productivity. The consistency of themes across respondents validates the importance of systematic material handling planning. The study also reveals a gap between awareness and implementation, particularly in small and medium-scale industries.

V. CONCLUSION

This study presented a qualitative assessment of material handling system improvements based on open-ended responses from 53 engineers in engineering industries. The findings highlight the need for material-specific handling strategies, integrated safety controls, layout optimization, waste elimination, proactive maintenance, and balanced automation. Recognizing material handling as a separate operational pillar can significantly enhance cost competitiveness, safety performance, and overall operational effectiveness. The study is limited to qualitative inputs from a finite sample size. Future research may combine qualitative findings with quantitative performance data, simulation models, or case studies to validate the impact of suggested improvements.



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