Review on Development of a Portable Machine for Lifting Bricks/ Other Material for Civil Constructional Works.

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Abstract

Material handling in civil construction remains one of the most labor-intensive and hazardous operations, particularly in small- and medium-scale projects where advanced lifting equipment is often unavailable due to cost, size, and power constraints. Manual lifting of bricks to elevated floors leads to reduced productivity, increased worker fatigue, and a higher risk of musculoskeletal injuries. This review paper presents a comprehensive study of existing brick lifting and material handling systems used in civil construction, with a specific focus on portable, low-cost, and energy-efficient lifting mechanisms. Various traditional and modern lifting methods, including manual handling, rope-and-pulley systems, hoists, cranes, and motorized lifting devices, are reviewed and classified based on portability, power requirement, cost, safety, and operational efficiency. A comparative analysis highlights the limitations of existing systems in addressing the needs of small construction sites. Based on this analysis, critical research gaps and challenges are identified, emphasizing the need for compact, battery-operated, and adaptable lifting solutions. Finally, future research directions are proposed, focusing on solar-powered systems, automation, ergonomic design, and smart control integration. The review supports the development of a portable brick lifting machine as a viable solution for sustainable and safe construction practices.

Keywords

Portable lifting machine, brick handling, PMDC motor, construction automation, material handling systems, low-cost mechanization.

1. Introduction

The construction industry is a cornerstone of economic development, yet it continues to rely heavily on manual labor for material handling tasks. Among these tasks, lifting bricks and construction materials to higher floors is particularly demanding and time-consuming. Traditional practices such as carrying bricks manually or using rope-and-bucket arrangements not only reduce efficiency but also pose significant safety risks to workers.

With increasing emphasis on **worker safety, productivity enhancement, and mechanization**, there is a growing demand for innovative material handling solutions tailored for small-scale construction environments. Large lifting

systems such as tower cranes, elevators, and hydraulic hoists, although efficient, are economically unfeasible and spatially impractical for small and medium projects.

Recent advancements in **mechanical system design, low-voltage electric drives, and portable manufacturing solutions** have opened new opportunities for developing compact lifting mechanisms. The concept of a **portable brick lifting machine powered by a PMDC motor and battery source** represents an important step toward affordable mechanization in construction.

This review paper systematically examines existing brick lifting technologies and highlights the need for a **low-cost, portable, and energy-efficient lifting system** suitable for small construction sites.

2. Review of Related Work

Hasan Iqbal et al. [01] developed a **Design of a Brick lifting machine** based on the working principle of gearless traction elevators to lift up to 50 bricks safely and efficiently. The study mainly improves construction safety by reducing manual handling, lowering labor effort, and optimizing power consumption using a DC series motor and counterweight system. However, the paper lacks experimental validation, field testing results, economic feasibility analysis, and discussion on automation or control systems for real construction environments.

Prateek Sharma et al. [02] presented a study on the **Design and fabrication of a brick lifting machine** aimed at reducing human effort, time, and labor cost in construction work. The work improves efficiency through a conveyor–chain drive mechanism with low power consumption. However, it lacks detailed automation, advanced safety analysis, and large-scale industrial feasibility validation.

Nurul Nazihah Jamil et al. (2024) [03] proposed a **Portable brick lifting machine to improve safety and efficiency in construction sites.** The study enhances traditional designs by focusing on portability, ergonomic use, and higher lifting capacity with detailed CAD and simulation analysis. However, the work is limited by the absence of real-time field testing and long-term performance evaluation.

S. K. Kotmire et al. (2024) [04] presented the **Design and fabrication of a material lifting machine** aimed at improving efficiency, safety, and reliability in construction and industrial material handling. The study strengthens traditional lifting methods through detailed design calculations, pulley and power transmission analysis, and practical fabrication. It highlights reduced manual labor and improved load-handling capability. However, the work lacks advanced automation features and extensive on-site performance validation

2.2 Mechanical Hoists and Winch Systems

Mechanical hoists driven by AC motors or internal combustion engines are widely used for vertical lifting. While effective, these systems are typically bulky, require a continuous power supply, and involve high installation and maintenance costs.

2.3 Crane-Based Lifting Systems

Tower cranes, mobile cranes, and hydraulic cranes dominate large-scale construction. However, their high capital cost, skilled operation requirements, and lack of portability make them unsuitable for small projects.

2.4 Low-Cost Motorized Lifting Devices

Recent research has focused on **motorized lifting mechanisms using DC motors, gearboxes, chain-sprocket drives, and wire rope systems**. These studies emphasize simplicity, torque amplification, and ease of fabrication. Battery-operated systems have been reported to improve flexibility and reduce dependency on grid power.

2.5 Renewable Energy Integration

Some experimental models integrate **solar panels with battery storage**, enabling eco-friendly operation and suitability for remote construction sites. However, these systems often lack optimized mechanical design and load-handling stability.

3. Classification of Existing Brick Lifting Systems

Existing systems can be classified based on **power source, mobility, and operational scale**:

3.1 Based on Power Source

- Manual systems
- Electric (AC-powered) systems
- Battery-operated DC systems
- Solar-assisted systems

3.2 Based on Portability

- Fixed installations (cranes, elevators)
- Semi-portable hoists
- Fully portable lifting mechanisms

3.3 Based on Load Capacity

- Light-load systems (manual, rope-based)
- Medium-load systems (motorized hoists)
- Heavy-load systems (cranes, elevators)

3.4 Based on Control Method

- Manual control
- Switch-controlled motorized systems
- Remote-controlled systems

4. Comparative Analysis of Existing Systems

Paper / Model	Mechanism	Power System	Load Capacity	Key Feature	Limitation
Brick Lifting Machine (IJEAT, 2014)	Gearless traction with rope & counterweight	D.C. series motor (≈3.6 HP)	~100 kg (≈50 bricks)	High efficiency elevator-type lifting	Complex design, higher cost
Portable Brick Lifting Device (RPMME, 2024)	Conveyor belt with rollers & chain drive	Electric motor-driven conveyor	80.51 kg, 2368 bricks/hr	Portable and high productivity	Limited lifting height (3.5–5 m)

Design & Fabrication of Brick Lifting Machine (IJSRD, 2019)	Inclined conveyor with gearbox	Quarter HP motor + worm gear	Continuous lifting (80–90 bricks/min)	Low power consumption	Industrial scalability issues
Material Lifting Machine (IJIRT, 2024)	Pulley, winch drum & chain drive	Mechanical/gear transmission	100–150 kg	Simple fabrication and low maintenance	Semi-manual operation

The analysis indicates that **portable motorized lifting systems** offer the best balance between cost, safety, and efficiency for small construction projects.

5. Research Gaps and Challenges

Despite advancements, several gaps remain:

- Lack of **standardized portable lifting systems** specifically designed for brick handling.
- Limited adoption of **low-voltage DC motor-based lifting mechanisms**.
- Insufficient focus on **ergonomics and worker safety** in small-scale solutions.
- Challenges in **load stability, guided motion, and torque optimization**.
- Limited field validation of **solar-powered lifting systems**.
- Absence of smart control and overload protection in low-cost designs.

6. Future Research Directions

Future studies should focus on:

- Optimization of **chain-sprocket/gearbox design** for higher torque efficiency.
- Use of energy **efficient drive trains** to lower the running cost.
- Development of **easy loading and unloading system**.
- Use of **lightweight/composite materials** for improved portability
- Ergonomic redesign to further reduce labor involvement.

7. Conclusion

This review highlights the critical need for **portable, low-cost, and energy-efficient brick lifting systems** in small-scale civil construction. Existing solutions either lack affordability, portability, or operational safety. The analysis strongly supports the development of a **battery-operated portable brick lifting machine using a PMDC motor, gearbox, and guided lifting mechanism**. Such systems have the potential to significantly reduce labor effort, enhance productivity, and improve safety. With further research and refinement, portable lifting machines can play a vital role in the sustainable mechanization of construction practices.

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