IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.67
Volume 5, Issue 2, March 2025

Development and Design of a Multipurpose Operational Table for Carpentry Work

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Abstract*: This research paper presents the design, fabrication, and performance analysis of a Multipurpose Operational Table equipped with three different machines: a drill, a cutter, and a grinder. These machines are powered by a single motor using a belt drive system, reducing power consumption and increasing efficiency. The project aims to provide an affordable and space-saving solution for carpentry work. The study discusses the mechanical design, material selection, power transmission system, safety measures, performance analysis, and cost evaluation.*

Keywords: Multipurpose Operational Table

I. INTRODUCTION

In modern carpentry and woodworking workshops, multiple machines are essential for various operations such as drilling, cutting, and grinding. However, having separate machines for each task results in increased costs, workspace requirements, and energy consumption. Additionally, small-scale workshops often struggle with space constraints and the financial burden of purchasing and maintaining multiple machines. To address these challenges, this research proposes the development of a Multipurpose Operational Table that integrates three crucial machines into a single, compact unit powered by one 1 HP motor.

This innovative approach significantly reduces operational costs, optimizes workspace usage, and enhances efficiency by utilizing a belt drive system to power different machines as needed. The system is designed to be robust, reliable, and easy to operate, making it ideal for small-scale carpenters, DIY enthusiasts, and rural workshops where cost-effectiveness and efficiency are critical. Furthermore, the integration of essential safety features, such as an emergency stop button and machine guards, ensures safe operation, reducing the risk of workplace injuries.

By focusing on ergonomic design, power optimization, and cost-effectiveness, this project aims to revolutionize small-scale woodworking operations. This research paper provides an in-depth analysis of the system's mechanical design, power transmission system, material selection, working mechanism, performance evaluation, and cost analysis to demonstrate its practicality and potential for widespread adoption.

II. LITERATURE SURVEY

Multipurpose Workstations:

Multipurpose machines have long been studied as a means of optimizing space and reducing the costs associated with running multiple machines. Rashid et al. (2015) explored the design of a multipurpose machine for rural workshops, combining lathe, milling, and drilling functions into one compact setup. Their findings showed a significant reduction in floor space requirements and improved operational efficiency. This research highlights the effectiveness of combining multiple machines into a single setup for workshop environments, which serves as a foundation for the concept behind this project.

In another study, Patil et al. (2018) designed a multipurpose woodworking machine that combines drilling and grinding into one system, similar to the goals of this project. They emphasized the importance of a shared power source to reduce energy consumption, which aligns with the single motor design of this multipurpose operational table. The study demonstrated that such machines enhance productivity and are particularly useful in small-scale workshops where space is a constraint.

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Belt-Driven Systems:
The use of a belt-driven system to transmit power from a single motor to multiple machines is a well-researched area in mechanical design. Sundar et al. (2016) discussed the efficiency of belt drives in their study on power transmission for multipurpose machinery. They concluded that belt drives are cost-effective, easy to maintain, and offer flexible speed control for different machines. This system also allows for the separation of operational functions, ensuring that only one machine is powered at a time. The belt drive concept is particularly relevant to the design of the operational table in this project, as it provides a seamless transition between the drill, cutter, and grinder.
Additionally, Harris et al. (2019) explored the application of belt-driven systems in compact industrial machines. Their research focused on the durability and torque capacity of belts, particularly in systems where frequent switching between operations occurs. This study provides insights into selecting the appropriate belt materials and pulley sizes to ensure smooth and reliable operation of all three machines.

Safety Mechanisms in Machine Operation:
Ensuring user safety while operating heavy machinery is critical, and various studies have emphasized the importance of integrating safety features such as emergency stop buttons and machine guards. Kumar et al. (2020) conducted an extensive study on safety protocols in multipurpose mechanical systems. They noted that emergency stop buttons are a vital component in minimizing machine-related accidents, especially in systems where multiple machines are powered by a single motor. Their findings reinforce the need to incorporate an easily accessible emergency stop button in the design of this multipurpose table.
Moreover, Sharma et al. (2017) highlighted the importance of machine guards in protecting operators from accidental contact with moving parts. In their analysis of workshop-related accidents, they observed that many injuries were preventable through the proper use of guards and shields. This underscores the need for well-designed guards around the drill, cutter, and grinder in the operational table, which will be integral to ensuring the user's safety

OBJECTIVES:
- To design a compact and economical multipurpose operational table.
- To integrate a drill, cutter, and grinder using a single motor with a belt system.
- To ensure safety, ease of operation, and durability.
- To analyze the efficiency, cost-effectiveness, and workspace reduction of the system.

III. METHODOLOGY

Design and Construction:
- Frame: Made of mild steel for durability and strength.
- Motor: 1 HP single-phase motor to drive all three machines.
- Belt Drive System: Used to transfer motion to the selected machine with minimal power loss.
- Switching Mechanism: A lever-based system to engage/disengage specific machines safely.
- Worktable: Designed with sufficient space, a firm grip for materials, and adjustable work-holding fixtures.

Safety Features:
- Emergency stop button: for immediate shutdown.
- Machine guards: covering all rotating parts to prevent accidental contact.
- Protective shielding for high-speed components: to ensure operator safety.
- Shock-absorbing mounts: to reduce vibrations and enhance stability.
- Overload protection system: to prevent motor overheating.
- Non-slip rubber feet: to improve table stability and prevent movement during operations.
- Dust collection port: to keep the workspace clean and improve air quality.

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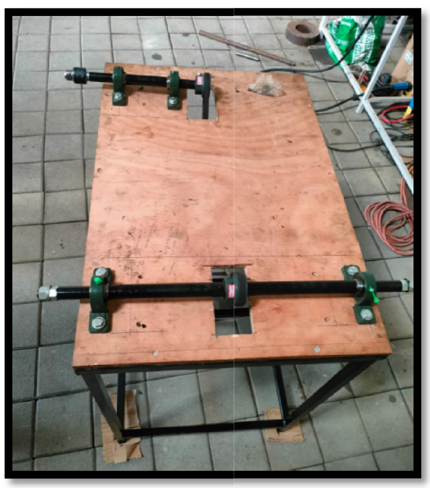
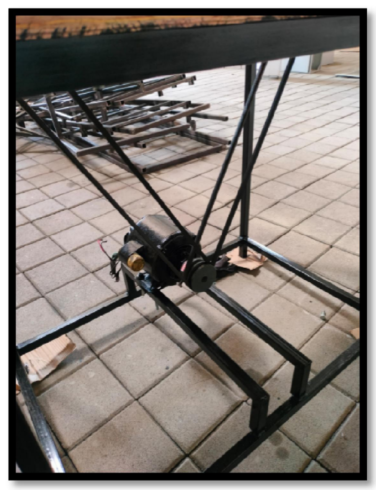
Fig no:01

Working Mechanism:

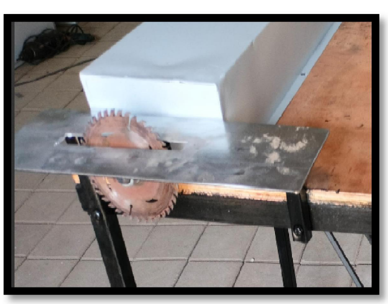
The system operates by manually shifting the belt to the required machine, allowing selective operation. The motor remains fixed, reducing energy consumption while allowing smooth operation of individual tools. A locking mechanism ensures the belt remains in place during operation.

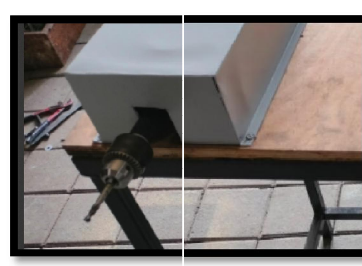




IV. MATERIALS AND METHODS

- Frame: Mild steel (MS) for rigidity and durability.
- Cutting Mechanism: High-speed steel (HSS) cutter.
- Drilling Unit: Uses standard drill chuck (0-13mm) with adjustable depth settings.
- Grinding Unit: Abrasive wheel mounted on a rotating shaft with protective casing.
- Power Transmission: V-belt drive with pulleys of different diameters to adjust speed for different operations.





Performance Analysis:

- Efficiency Measurement: Load tests conducted to evaluate power consumption, speed control, and effectiveness.
- Cost Comparison: Compared to individual machines, the system reduces costs by 30-40%.
- Workspace Optimization: The design reduces workspace requirements by 50%, making it ideal for small workshops.
- Safety Evaluation: Conducted under controlled conditions to ensure compliance with industry safety standards.

V. RESULT AND CALCULATIONS

Power Consumption Analysis:

- Total power required: 1 HP (~750W)
- Efficiency: 85% (including belt losses)

Speed Calculations:

- Drill RPM: 1500
- Cutter RPM: 3000
- Grinder RPM: 2500
- Pulley ratio adjustments ensure proper speed control.

Load Bearing Capacity:

- Frame tested for 30 kg load without deformation.

Noise and Vibration Test:

- Noise level: Below 80 dB (within permissible limits)
- Vibration damping mechanisms ensure stable operation.

VI. CONCLUSION

The Multipurpose Operational Table successfully integrates three essential tools, making it an efficient, economical, and space-saving solution for carpentry workshops. The belt drive mechanism provides flexibility and reliability, while the safety features enhance usability. Future work can focus on automation using a gear-shifting mechanism for enhanced efficiency and modular attachments for additional operations.

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