



IJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** IV **Month of publication:** April 2026

DOI: <https://doi.org/10.22214/ijraset.2026.79448>

www.ijraset.com

Call:  08813907089

E-mail ID: ijraset@gmail.com

Fabrication of Patient Lift Wheelchair with Convertible Bed

Akash M¹, Akshay K², Deepak P³, Mohammed Harshad N⁴, Assist.Prof. Anoop KJ⁵

Mechanical Engineering Department, APJAKTU

Abstract: *This project presents the fabrication of a patient-lift wheelchair with a convertible bed, integrating the functions of a wheelchair, patientlift, and hospitalbed into a compact unit. The system enhances patient comfort and reduces caregiver effort during transfer and repositioning. Unlike traditional wheelchairs, which provide only mobility, this design allows smooth transformation from sitting to flatbed positions using mechanical linkages, pivot joints, and motorized or hydraulic actuators. It also features a patient- lifting mechanism for vertical adjustment without manual handling. Lightweight, durable materials, locking castor wheels, and ergonomic controls ensure safety, stability, and ease of operation. The design is cost-effective, space-saving, and suitable for hospital and home care, improving independence and comfort for paralyzed, elderly, or post-surgical patients while reducing caregiver workload.*

Keywords: *Patient-lift wheelchair, Convertible bed, Caregiver assistance, Mechanical actuators, Patient comfort*

I. INTRODUCTION

Advancements in assistive and rehabilitation technologies aim to enhance patient comfort, mobility, and safety. Conventional wheelchairs, patient lifts, and hospital beds often operate separately, increasing caregiver effort, space requirements, and costs. This project integrates a convertible bed mechanism into a patient-lift wheelchair, enabling seamless transformation from sitting to lying or semi-reclined positions using adjustable backrest and leg-rest mechanisms with mechanical linkages, pivot joints, and electric or manual actuators. The system allows vertical lifting from bed to wheelchair height, improves patient comfort, safety, and independence, and reduces caregiver strain. Lightweight, durable materials and ergonomic features ensure practicality for home and institutional care. The design supports automation, portability, and future research in rehabilitation robotics, offering a cost-effective, versatile, and efficient assistive solution.

II. METHODOLOGY

This project employs a systematic approach to develop a patient-lift wheelchair with a convertible bed. Initially, existing wheelchair and hospital bed designs were reviewed to identify limitations in space, cost, and caregiver effort. Conceptual designs were developed, integrating adjustable backrest, leg-rest linkages, and manual actuators for smooth transformation between sitting and lying positions. Lightweight and durable materials were selected for the frame and mechanical components. A 3DCAD model was created, followed by mechanical simulations to assess stress, stability, and functionality. The prototype was fabricated, assembled, and tested for patient comfort, vertical lifting efficiency, and caregiver workload reduction. Observations and performance data were analyzed to validate design objectives and ensure safety, ergonomics, and practicality for home and institutional use.

III. DESIGN AND CALCULATIONS

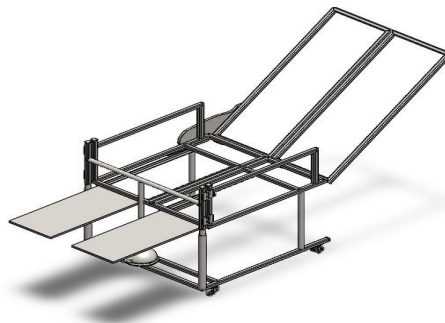


Figure 1: 3D Design of patient lift wheelchair with convertible bed

The design of the patient lift wheelchair with a convertible bed was developed using SolidWorks, where the main components—base frame, upper frame, seat, and backrest—were modeled and assembled. The base frame was designed as a strong rectangular structure using GI square pipes (25 × 25 × 2 mm) to support the entire load and ensure stability. Above this, the upper frame was created to hold the seat and backrest while allowing connection with the lifting mechanism. The seat was modeled as a flat support surface fixed to the upper frame, while the backrest was designed as a separate component connected through a hinge joint, enabling smooth reclining motion for bed conversion. All parts were assembled using appropriate mates in SolidWorks to simulate real-time movement and ensure proper alignment, strength, and functionality of the complete system before fabrication

DIMENSION OF MACHINE

- Seat length = 60 cm
- Seat width = 55 cm
- Backrest height = 75 cm
- Backrest width = 55 cm
- Frame height = 40 cm

THEORETICAL LOAD CALCULATION

- Material = GI steel
- Yield strength, $\sigma_y = 250 \text{ MPa}$
- Factor of Safety, $FOS = 3$

Allowable Stress

$$\sigma_{allow} = \frac{\sigma_y}{FOS}$$

$$\sigma_{allow} = \frac{250}{3}$$

$$\sigma_{allow} = 83.33 \text{ MPa}$$

Maximum Bending Moment

$$M = \sigma_{allow} \cdot Z$$

$$M = 83.33 \times 1307.6 = 108960 \text{ Nmm}$$

Load on Beam

For simply supported beam:

$$M = \frac{W \cdot L}{4}$$

$$W = \frac{4 \times 108960}{600}$$

$$W = 726.4 \text{ N}$$

Total Load Capacity

Assuming seat carries 70% of total load:

$$W_{total} = \frac{726.4}{0.7} = 1037.7 \text{ N}$$

Convert to Load in kg

$$m = \frac{W}{g} = \frac{1037.7}{9.81}$$

$$m \approx 106 \text{ kg}$$

IV. COMPONENTS USED FOR FABRICATION

A. GI Pipes

The frame is constructed using $25 \times 25 \times 2$ mm square GI pipes, offering a good balance of strength, rigidity, and lightweight design.

The hollow sections provide sufficient load-bearing capacity, while the 2 mm thickness resists bending and impact during operation. The galvanized coating protects against corrosion, enhancing durability and reducing maintenance in harsh conditions. The



Figure 2: GI Square Pipe

B. Seat Back Hinge Recliner

The car seat recliner mechanism works based on a ratchet and pawl with gear locking system that allows controlled angular movement of the backrest. In its normal condition, the internal gear teeth are engaged, locking the seat firmly at a fixed position. When the user operates the release lever, the pawl disengages from the gear teeth, allowing the backrest to rotate freely about the pivot joint. This rotation enables adjustment of the seat angle from an upright sitting position to a reclined or flat position. Once the desired position is reached, releasing the lever activates the spring mechanism, which pushes the pawl back into engagement with the gear teeth, thereby locking the backrest securely in place. This simple mechanical arrangement ensures smooth operation, stable positioning, and safe load-bearing capacity, making it suitable for applications like a convertible patient lift wheelchair cum bed.



Figure 3: Seat Back Hinge Recliner

C. Hinges

The hinge operates on a simple rotational motion principle. The two plates are connected by a central pin, which acts as the axis of rotation. When force is applied, one plate rotates relative to the other around this pin, allowing angular movement. The design ensures smooth motion while maintaining alignment and load support between the connected parts



Figure 4: Hinges

D. Screwjack

The screw jack works based on the principle of a power screw. When the handle is rotated, it turns the threaded screw inside the nut. Due to the helical threads, this rotational motion is converted into vertical linear motion, causing the lifting head to move upward or downward. The friction between the screw and nut helps to hold the load in position without slipping, making the system self-locking in most cases.



Figure5:ScrewJack

E. Casterwheels

The caster wheel works on a combination of rolling and swiveling motion to provide smooth and flexible movement. The wheel rotates about its horizontal axle, allowing forward and backward motion with minimal friction. At the same time, the swivel mechanism at the top contains a bearing assembly that allows the entire wheel to rotate 360 degrees about a vertical axis. This enables the wheel to automatically align itself in the direction of movement, making it easy to change direction without lifting the structure. When the brake lever is applied, it restricts the rotation of the wheel and/or the swivel motion, thereby locking the position and ensuring stability. This dual-motion mechanism makes caster wheels highly effective for applications requiring easy mobility and control, such as in a patient lift wheelchair cum bed.



Figure6:CasterWheels

V. FABRICATION PROCESS

Metal fabrication is the process of cutting, shaping, and assembling metal materials to create structural components and parts. It involves operations such as cutting, drilling, welding, grinding, finishing operation & painting to achieve the desired shape and strength. In this project metal fabrication is used to construct the frame, trailer platform, and mounting structures, ensuring durability, stability, and proper alignment of all components. The fabricated parts are designed to withstand applied loads and provide reliable performance of the system.

F. Cutting

Cutting operation in metal fabrication involves removing unwanted material from metal pieces to obtain required shapes and sizes for trailer components like the frame and brackets. In this project, square pipes are cut to required dimensions and prepared for welding. Cutting is done using tools such as hacksaw and cutting machines. Proper measurement and accurate cutting ensure correct fitting, strength, and ease of assembly. Edges are finished after cutting to remove burrs and ensure safety.



Figure8:Cutting

G. Drilling

Drilling operation was performed to create accurate holes in the frame of the patient lift wheelchair for proper assembly. A bench drilling machine with suitable drill bits was used to achieve the required hole sizes. The workpiece was securely clamped, and marking was done before drilling to ensure precision. Cutting fluid was applied to reduce heat and improve tool life. This operation ensured strong fastening of components like hinges, seat, backrest



Figure 9:Drilling

H. Welding

Welding operation was carried out to join the metal parts of the patient lift wheelchair frame securely. Arc welding was used to provide strong and permanent joints between structural members. The surfaces were cleaned before welding to ensure good bonding. Proper safety measures like wearing gloves and a welding helmet were followed. This operation ensured high strength, rigidity, and durability of the wheelchair structure.



Figure10:Welding

I. Grinding

Grinding operation in this project is carried out to smooth the cut and welded surfaces of metal components. It is used to remove sharp edges, burrs, and excess weld material to improve surface finish and ensure safe handling. Grinding also helps in achieving proper fitting of parts and enhances the overall appearance and quality of the fabricated wheelchair.



Figure11:Grinding

J. Painting

Painting operation in this project is carried out to protect metal components from rust and corrosion and to improve the overall appearance of the trailer. After proper surface cleaning, paint is applied evenly on all parts to ensure durability, smooth finish, and longer service life.



Figure12:Painting

K. Upholstery Work

Finishing operation in this project is carried out using a wire brush for surface cleaning, polishing, and removal of frust. This process improves surface quality and prepares the metal components for painting or further treatment, ensuring better appearance and durability.



Figure 13: Upholstery Work

VI. FINAL PRODUCT AND OPERATION



Figure 14: Final Product



Figure 15: wheelchair sitting and lying position

The final product developed in this project is a patient lift wheelchair with a convertible bed, fabricated using galvanized iron (GI) material to ensure strength, corrosion resistance, and long service life. The GI frame is joined using proper welding techniques to provide durability and stability under load conditions. A screw jack and hinge mechanism are incorporated to enable smooth conversion from wheelchair to bed and to assist in safe patient lifting with minimal effort. The wheelchair is equipped with caster wheels for easy movement and locking mechanisms for safety during stationary use. Cushioning and upholstery are provided on the seat and backrest to enhance patient comfort and reduce the risk of pressure sores. Overall, the use of GI material makes the system cost-effective.

VII. RESULT AND DISCUSSION

The patient lift wheelchair with convertible bed was successfully designed, fabricated, and evaluated under practical conditions. The system enabled smooth conversion between wheelchair and bed positions, ensuring patient comfort and ease of operation. The screw jack mechanism provided controlled and safe lifting and lowering, while the caster wheels and braking system ensured stable movement and safety. Experimental testing with a 70 kg load showed no signs of deformation, instability, or structural failure, confirming the reliability and stability of the design.

Theoretical analysis indicated a maximum load capacity of approximately 100 kg, providing an adequate factor of safety for real-world applications. Minor deflections observed during testing were within acceptable engineering limits and did not affect performance. While the GI frame offered high strength, replacing it with aluminium can reduce the overall weight by about 50% with only a slight reduction in strength, improving portability. Overall, the system is cost-effective, safe, and suitable for use in hospitals and home care environments, with scope for further improvements such as motorized lifting and lightweight materials.

VIII. CONCLUSION

The Patient Lift Wheelchair with Convertible Bed was successfully designed, fabricated, and tested to meet the intended objectives of improving patient handling and comfort. The system effectively combines lifting and bed conversion mechanisms into a single unit, reducing the need for multiple equipment in healthcare settings. The screw jack mechanism provided smooth and controlled lifting, while the reclining arrangement ensured easy transformation between wheelchair and bed positions. Experimental testing with a 70 kg load demonstrated stable performance without any structural failure, validating the reliability of the design within the theoretical capacity of 100 kg.

Overall, the project proves to be a cost-effective and practical solution for hospitals and home care applications, enhancing both patient safety and caregiver convenience. Although the use of GI material ensured sufficient strength, it increased the overall weight of the system. Future improvements such as the use of lightweight materials like aluminium, motorized lifting mechanisms, and enhanced ergonomic features can further improve efficiency, portability, and user comfort. This project demonstrates strong potential for real-world implementation and further development in assistive healthcare devices.

IX. ACKNOWLEDGEMENT

We would remember with grateful appreciation, the encouragement and support rendered by the authority of Eranad Knowledge City Technical Campus, especially Mr. ADARSH.T.K., Principal, Eranad Knowledge City Technical Campus, Manjeri, to successfully complete this project and Michael Shell and other contributors for developing and maintaining the IEEE LaTeX style files which have been used in the preparation of this template.

We express our deepest sense of gratitude to Mr. Sajan C., Head of the Department of Mechanical Engineering, project coordinator Mr. Anoop KJ., Assistant Professor, Department of ME and project guide Mr. Anoop KJ., Assistant Professor, Department of ME for their keen interest and constant encouragement with our work during all stages.

We greatly acknowledge all other staff members of the department and all our friends and well-wishers, who directly or indirectly contributed in this work and Michael Shell and other contributors for developing and maintaining the IEEE LaTeX style files which have been used in the preparation of this template. Our heartfelt thanks to my family members for their kind cooperation in completing this project and last but not least, we are indebted to God Almighty for being the guiding light throughout this project and helped us to complete the same within the stipulated time.

REFERENCES

- [1] Ahmed, S., & Rahman, M. (2020). Design and development of an automated patient transfer and lifting device. *International Journal of Engineering Research & Technology (IJERT)*, 9(3), 512-519.



- [2] Li, H., & Wang, J. (2018). Structural optimization of electric wheelchairs for improved patient comfort. *Journal of Mechanical Design*, 140(12), 1–10
- [3] Sato, T., & Kobayashi, M. (2019). Development of a multifunctional wheelchair with reclining and lifting features for elderly care. *International Conference on Robotics and Automation in Medical Applications*, 122–128.
- [4] Kumar, A., & Rajesh, R. (2021). Design and fabrication of a patient transfer mechanism integrated with wheelchair. *International Journal of Scientific & Engineering Research*, 12(5), 842–849.
- [5] Chang, C. C., & Hsu, L. W. (2020). Innovative assistive device design for patient mobility enhancement. *Journal of Biomedical Engineering and Technology*, 8(4), 23–29.
- [6] Lee, D., & Kim, J. (2022). Simulation-based structural analysis of powered wheelchairs using SolidWorks Motion and FEA. *Journal of Rehabilitation Science and Technology*, 15(2), 104–112.
- [7] Prakash, S., & Mahesh, P. (2019). Design analysis and fabrication of convertible patient lift bed cum wheelchair. *International Journal of Mechanical and Production Engineering*, 7(8), 38–45.
- [8] Ogawa, T., & Suzuki, Y. (2018). Human-centered design of transfer-assist wheelchairs for home care environments. *Assistive Technology Research Series*, 25(2), 93–101.
- [9] Singh, R., & Patel, K. (2023). Integration of IoT and automation in modern patient mobility systems. *Journal of Smart Healthcare Devices*, 6(1), 55–67.
- [10] Mohammed, H., & Shanmugam, S. (2024). Conceptual design of a convertible wheelchair-bed system for hospital applications. *Proceedings of the National Conference on Mechanical Innovations*, 45–52.



10.22214/IJRASET



45.98



IMPACT FACTOR:
7.129



IMPACT FACTOR:
7.429



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089  (24*7 Support on Whatsapp)