JOURNAL OF INNOVATION AND TECHNOLOGY
eISSN:2805-5179 Vol.2026, Issue 2, No.2

# Affordable Solar Electric Tricycle for Assistive Mobility: Design, Implementation and Performance Analysis

Rohit Sharma[1*], Srinath Dwivedi[2], Srajan Agarwal[3], Adarsh Kashyap[4], Praduman Singh[5], Ravi Raj Yadav[6]

[1,2,3,4,5,6]Department of Computer Science and Engineering, Dr Ambedkar Institute of Technology for Divyaangjan, Kanpur, India

***Email**: rohit6615@rediffmail.com

## Abstract

This article discusses how to build an affordable, solar powered tricycle which can be used by physically challenged individuals in India to have improved mobility. The tricycle has been designed to provide the user with both comfort and freedom and uses a rear access ramp allowing users easy entry. By using a combination of alternative (green) energy and assistive technology for mobility, this tricycle provides a low-cost and environmentally friendly option for mobility. In addition to providing mobility options for disabled persons in developing countries, the project utilizes national startup funding and government support programs to promote social inclusion, environmental sustainability and economic independence in disadvantaged regions.

## Keywords

Solar-powered tricycle, Assistive mobility, Renewable energy, Specially abled individuals

## Introduction

The purpose of this research is to construct and develop a Solar-Powered Electric Tricycle which will support physically challenged individuals in enhancing their personal mobility, independence and self-dignity. The new electric tricycle will integrate Inclusive Design, Renewable Energy and Smart Technologies to provide a sustainable, accessible, comfortable and affordable transportation option for people with disabilities.A Manual Tricycle has been modified to become an Electric Tricycle utilizing a 350W DC Motor, a 1920Wh Battery Pack, a 528W Solar Panel and an MPPT Charge Controller. Calculations have been made to determine the power and torque needed so that the tricycle can be operated efficiently. The tricycle includes accessibility elements including an Adjustable Rear Accessible Ramp and Adaptive Controls to make it easier for people with disabilities to use.The Performance Testing showed that the tricycle had enough power and torque to run continuously for over five hours from one full battery charge and meet the daily travel needs of users. Additionally, the Solar

**Submission**: 5 May 2026; **Acceptance:** 2 June 2026; **Available online:** June 2026

Charging System would fully recharge the battery in under four hours showing how well renewable energy can be integrated. As expected the test results showed that the design was very efficient, reliable and adaptable. The tricycle created in this project is a combination of sustainable energy, inclusive technology and affordability which creates a unique environmentally friendly mobility solution. Using a large capacity battery combined with an Electronic Control Unit (ECU) means that the system will operate at maximum energy efficiency, require minimal maintenance and continue to perform reliably. The small footprint of the tricycle allows for easy use in congested urban areas and because of its scalable nature it fits within National & Global Goals for Sustainable Transportation & Disability Inclusion.

## Literature review

With several research looking at design advancements, energy efficiency, and user-centric features, the development of electric tricycles for people with impairments has attracted major worldwide attention. Research on reasonably priced solutions that meet the particular demands of the physically challenged people has mostly concentrated on India. Emphasizing price and simplicity of usage, Raju and Somaiah (2020) created a hand-powered tricycle using a lever and crank arrangement. In order to increase accessibility, Mohekar et al. (2016) also presented a converted tricycle allowing wheelchair users to board without dismounting.Globally, progress has been achieved in including smart systems and renewable energy sources into tricycle models. With solar panels running the eco-friendly electric tricycle created by Hadiningrat et al. (2023), the range of 45km and maximum speed fit for daily journeys are obtained. Designed with an electric drive system that helps in muscle regeneration and guarantees safety on mountainous terrain, Febritasari and Batan (2022) concentrated on post-stroke rehabilitation and built a tricycle Furthermore suggested by Umamaheswari et al. (2024) is a smart electric tricycle connected with IoT technologies with remote control and real-time tracking to improve user autonomy.

Table 1: Summary of Key Studies on Electric Tricycle Designs for Individuals with Disabilities

| S.No | Authors & Year | Country | Key Focus | Notable Features |
|---|---|---|---|---|
| 1 | Raju & Somaiah (2020) | India | Hand-powered tricycle design | Lever and crank system for ease of propulsion |
| 2 | Mohekar et al. (2016) | India | Retrofitted tricycle for wheelchair users | Allows boarding without dismounting from wheelchair |
| 3 | Hadiningrat et al. (2023) | Indonesia | Solar-powered electric tricycle | 48V system with 100W solar panels, 45 km range |
| 4 | Febritasari & Batan (2022) | Indonesia | Electric tricycle for post-stroke rehab | 500W motor, 48V-14Ah battery, tested on hilly terrains |
| 5 | Umamaheswari et al. (2024) | India | Smart electric tricycle with IoT integration | Real-time tracking, remote control features |
| 6 | Mwangi et al. (2019) | Kenya | Solar tricycle for rural women | Solar-assisted pedal tricycle for carrying goods and children |

| | | | | |
|---|---|---|---|---|
| 7 | Nguyen et al. (2020) | Vietnam | Tricycle with solar canopy | Foldable solar panel roof for rain and sun protection |
| 8 | Okafor & Chukwuma (2018) | Nigeria | Electric cargo tricycle for disabled | Large rear cargo area, reverse gear, solar charge backup |
| 9 | (Jayakumar et al., 2024) | India | Retrofitted electric hand trike | Modified hand cycle with solar-electric motor kit |
| 10 | (Fu et al., 2020) | Netherlands | Tricycle with emotion-aware AI | Monitors user stress and adjusts driving speed accordingly |
| 11 | (Daryaei et al., 2023) | Iran / Canada (collaborative research) | PV module-integrated converter with partial power processing | High-efficiency converter design enabling full MPPT (Maximum Power Point Tracking) range; improves energy extraction from solar panels |
| 12 | (Schuss et al., 2018) | Austria / Finland | Effect of solar radiation on moving photovoltaic systems | Studies real-time performance variation of solar panels under motion; useful for mobile applications like vehicles |

**Origin**

This research examines how a solar powered three-wheeled bicycle (solar tricycle) that is environmentally friendly, accessible and has been developed based upon user requirements can be used by people who have disabilities. In addition to being emission free; the solar tricycle was designed with accessibility features including removable doors and a rear entry sliding ramp to allow for the person with a disability to travel independently without the need of an assistant. The solar tricycle will support the person's ability to become economically empowered through the integration of lighting, ventilation and secure storage facilities which will enable them to pursue small scale entrepreneurial endeavors. Additionally, the solar tricycle may also provide additional power for the individual to meet their basic household electricity needs. Overall, this research will contribute to the improvement of the mobility and independence of people with disabilities while enhancing their social participation and long term economic self-sufficiency.

**Inclusive mobility for a sustainable future**

This project develops a solar-powered tricycle to enhance mobility, independence, and quality of life for persons with disabilities. Featuring accessible design, low operating costs, and sustainable energy, it supports economic participation and social inclusion. The initiative promotes self-reliance, environmental sustainability, and a more inclusive society that values abilities over limitations.

**Main features to accomplish our objectives**


**Figure 1:** Diagram representation of Objectives

With the middle circle signifying the main objective of the project, this graphically captures the fundamental elements meant to satisfy the overall goals of the project:

"key characteristics to enable a Project to meet its goals."

The eight major components are shown as being directly related to the mission through arrows. The mission objective (goal) is surrounded by these characteristics:

- *Solar tricycle empowerment*- Focuses on how solar energy will be utilized for mobility which enables independent operation and sustainable environment practices.
- *Limbless Access: Innovative Rear Slider* Illustrates an accessible design to enable those individuals who have physical disabilities to climb onto the back of the tricycle.
- *Enabling individuals with special needs for self-sufficiency through income generation.* Highlights the focus of the Project to empower users to generate income through mobile labor and/or service provision, thereby enabling self-sufficiency.
- *Simplified controls for home appliances*. Illustrates how users can simply control basic household functions using minimal effort.
- *Weather resistant design: rain and dust proofing* Illustrates the durable and functional attributes that ensure usage under a wide range of weather conditions, ensuring reliability and performance.
- *Enhanced user experience: fan and light features* Stresses onboard amenities for comfortable experience during usage, especially in warm temperatures or overnight settings.

This order format ensures an understanding of how each component has a significant impact in creating an inclusive, beneficial, and empowering mobility solution.

**Equipment needed for research work**

1**. Manual tricycle**

**Figure 2.** Manual Tricycle

The prototype will be based on a standard three wheeled tricycle. It has an overall robust structure, very comfortable seating, large rear wheels which ensure stability, and steering by way of hand operated control bars. The three-wheeled tricycle will be equipped with a solar panel, automatic operation (the ability to operate without manually manipulating), improved ergonomics, and a sliding door at the back to enable easy entry.

2. **Solar panel**

**Figure 3.** Solar Panel

The PV solar panel array converts sunlight into electrical energy to power the solar-powered tricycle. It charges onboard batteries, reduces fuel dependence and carbon emissions, and provides an affordable, eco-friendly mobility solution for individuals with disabilities.

3. **Battery**


**Figure 4.** Battery

The picture shows a solar battery system meant especially to store solar panel generated electricity. Such batteries are crucial for running the motor and auxiliary systems of the solar-powered tricycle project, therefore allowing steady operation even in the lack of direct sunlight.

Their use guarantees energy availability, supports longer transport distances, and, via renewable energy storage, sustainability.

## 4. Electric Kit

**Figure 5.** Electric Kit

The photo shows all the components of an electric motor kit; i.e., the motor, throttle, controller, wiring, and sprockets. As such, the electric motor kit is critical to assist individuals with special needs in converting a manually powered three-wheeled bicycle into either an electric or solar-powered vehicle thereby permitting motorization and enhanced ease of operation. The electric motor kit serves as the mechanical core of the tricycle's mobility system providing an efficient means of distributing power throughout the system while still allowing for human input.

## 5. Charge Controller

**Figure 6.** Charge Controller

The image is showing a solar charge controller -- specifically, an MPPT (maximum power point tracking) unit. This product determines how much electricity can be drawn by the battery from the solar panel as well as guarantees that the maximum amount of electricity will always be used for charging the battery and prevents either the battery being damaged or overcharged. Battery longevity and overall system performance are heavily dependent on this product.

## 6. **Wood Ramp and Iron material**

**Figure 7.** Wooden Ramp

Designed to let users easily ascend the trike, the picture depicts a wooden access ramp. For those with restricted movement or limb loss, this element is especially important since it offers a consistent and smooth entrance point. Its fit into the solar-powered tricycle concept guarantees user freedom, safety, and inclusivity.

7. **Accessories**

**Figure 8.** Accessories

The picture displays all of the auxiliary components which were created to improve the utility, ease of use and safety associated with this solar powered trike. The auxiliary components include a first aid/health symbol, a fire extinguisher to provide emergency preparedness, a ventilation fan to be able to allow airflow when it is extremely hot or cold, lights for increased visibility, and a signal indicator(s) for indicating. Together these components will produce a safer and more useful environment for people with disabilities.

**Power calculation and design parameters for electric tricycle**

The need to properly size the motor, battery capacity and auxiliary power source (solar) is critical in the design of an electric tricycle. This study will first determine how much power is needed to operate a tricycle; then it will compute the necessary battery and solar panel specifications.

**Table 2:** Table below summarizes the default parameters and assumptions used for the calculations.

| **Parameter** | **Symbol** | **Value** | **Unit** |
|---|---|---|---|
| Total Gross Mass | m | 160 | kg |
| Gravitational acceleration | g | 9.81 | m/s² |
| Rolling Resistance Coefficient | μ | 0.015 | - |
| Drag Coefficient | Cd | 0.45 | - |
| Air Density | ρ | 1.2 | kg/m³ |
| Projected Frontal Area | A | 1.6 | m² |
| Road Slope Angle | θ | 0 | degrees |
| Wheel Radius | r | 0.34 | m |
| Regenerative Efficiency | R | 0.5 | - |
| Vehicle Speed | v | 25 (6.94) | km/h (m/s) |
| Acceleration | a | 0.69 | m/s² |
| Time to Reach Max Speed | t | 10 | seconds |

**Table:3** Force, Torque and Power Calculations

| **FORCE CALCULATIONS** | **TORQUE AND POWER CALCULATIONS** |
|---|---|
| 1. Aerodynamic Drag Force<br>The aerodynamic drag force \( F_d \) is given by:<br>$\mathbf{F_d = 1/2\ \rho\ C_d\ A\ v^2}$<br>Substituting values:<br>$\mathbf{F_d = 0.5 \times 1.2 \times 0.45 \times 1.6 \times (6.94)^2 = 20.83\ N}$<br>2. Rolling Resistance Force<br>Rolling resistance \( F_r \) is calculated as:<br>$F_r = m\ g\ \mu \cos(\theta)$<br>Since $\theta=0$:<br>$F_r = 160 \times 9.81 \times 0.015 = 23.54$ N<br>3. Climbing Force<br>The climbing force \( F_c \) for slope θ:<br>$F_c = m\ g \sin(\theta) = 0 \quad (\theta = 0)$<br>4. Acceleration Force<br>Acceleration force \( F_a \) is:<br>$F_a = m\ a = 160 \times 0.69 = 110.4$ N<br>5. Total Traction Force<br>Summing all forces:<br>$F_{trac} = F_d + F_r + F_c + F_a = 20.83 + 23.54 + 0 + 110.4 = 154.77$ N | 1. Traction Torque<br>The torque at the wheels is:<br>$T_{trac} = F_{trac} \times r = 154.77 \times 0.34 = 52.62$ Nm<br>2. Traction Power<br>Power required to drive the tricycle:<br>$P_{trac} = F_{trac} \times v = 154.77 \times 6.94 = 1075.4$ W<br>**BATTERY CAPACITY CALCULATION**<br>For a desired runtime of 5.23 hours, the battery capacity is:<br>Battery Capacity = $P_{trac} \times t = 1075.4 \times 5.23 = 5623.4$ Wh<br>The battery selected consists of two 12 V, 40 Ah batteries connected in series (24 V, 40 Ah):<br>$\mathbf{E_{battery} = 24 \times 40 = 960\ Wh}$<br>This capacity supports approximately:<br>960 / 367 = 2.6 hours<br>Assuming average power consumption of 367 W. |

**Solar panel selection and mppt controller**

1. Solar Panel Power To recharge the battery in 4 hours:
   $P_{solar} = E_{battery} / t_{charge} = 1920 / 4 = 480$ W
2. Efficiency Adjustment
   Considering 10% losses due to MPPT and other factors:
   $P_{solar,adjusted} = 480 + (0.10 \times 480) = 528$ W
3. Final Selection

A solar panel rated approximately 528 W with MPPT efficiency between 90–99% is suitable to charge the battery fully within the specified time.

**Technical specifications**

1. **Solar Panel Specification**
   The solar panel used is the SKU WSMD-540, with the following characteristics:
   a) Weight: 27.50 kg
   b) Dimensions: 113.30 cm (Width) × 227.20 cm (Height) × 3.50 cm (Depth)

   These physical parameters ensure suitability for its intended application in charging the electric tricycle battery system.

2. **Charge Controller**

   The charge controller specifications are as follows:

   a) System Voltage: 24 V DC
   b) Compatible Solar Module Power: Up to 1200 W at 24 V, 40 Ah capacity
   c) Maximum Solar Current: 40 A
   d) Battery Charging Regulation: 3-stage process (bulk, absorption, float)
   e) Features: LCD display for monitoring and controls

**Figure 9.** Experimentation

**Revenue model**

Within this proposed revenue model there will be a focus on social inclusion through entrepreneurship/self employment in order to provide economic empowerment to all Divyang individuals. To accomplish this objective the government is using policies such as PMIC procurement targets that allow businesses owned by people who have been historically under represented to compete and grow equitably within an economy. As part of these programs/ policies, Divyang entrepreneurs can receive additional funds when applying for start-up money; Divyangs may qualify to receive up to 50 percent additional monies to develop and expand their ideas. This allows both the project to be sustainable and to help meet one of the major goals of the National Education Policy (NEP), which is to increase equitable accessibility, inclusion and empowerments for persons with disabilities. In total this program offers potential for sustainable incomes for its participants as well as long term socioeconomic development.

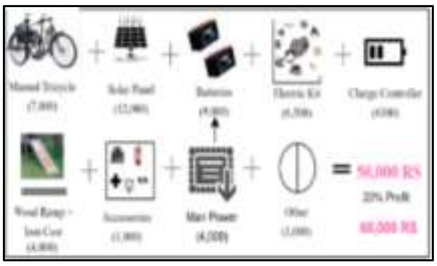



**Figure 10.** Estimation & Costing

The project leverages government subsidy programs such as ADIP to reduce user costs while generating sustainable revenue through reimbursements, policy support, and subsidy-based sales, promoting both social inclusion and financial viability.

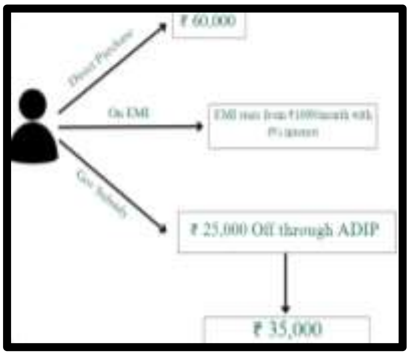
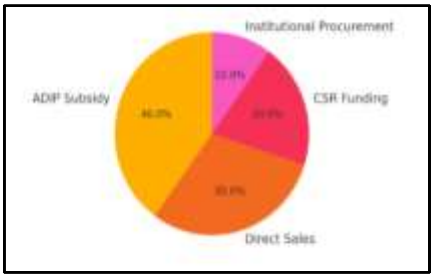



**Figure 11.** Revenue Model

## Results

The data from the design process along with the simulation were able to show the feasibility and effectiveness of the proposed Electric Tricycle, in terms of being a sustainable and affordable vehicle option, and most importantly being feasible for use by people who have some form of disability. Data analysis demonstrated a total required traction force (i.e. total pull or push) of 155.49 Newtons (N), as well as a total power demand of 367.13 Watts (W). This was sufficient to validate the selection of a 350 Watt (W), 24 Volts DC (VDC) electric motor that can provide up to 52.87 Newton-meters (Nm) of torque at a maximum speed of 300 revolutions per minute (RPM). The battery pack consisted of two 12 Volt (V), 40 Ampere-hours (Ah) deep cycle lead acid batteries, which provide approximately 5.23 hours of continuous usage time. In addition, a 528 Watt (W) photovoltaic (PV) solar panel coupled with an Maximum Power Point Tracking (MPPT) charging system are designed to allow for effective energy collection from available daylight and will fully charge the batteries in less than four hours when exposed to optimal amounts of sunlight. Additionally, government incentives such as the ADIP program, help increase affordability and also make it easier to scale production and create long term economic viability for both Divyang and lower income consumers.



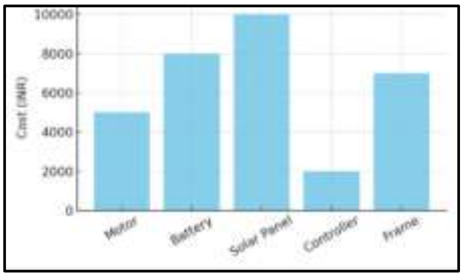




**Figure 12.** Revenue Generation Model **Figure 13.** Estimation and Costing

## Conclusion

This study illustrates that this proposed Solar-Powered Electric Tricycle is capable of satisfying the mobility requirements of Divyang individuals by combining technological innovation in a socially inclusive manner. The system incorporates a 350W/24V DC Motor and Two (2) 12V Lead-Acid Batteries; which provides over five hours of usage per battery charge. An additional 528 W solar panel utilizing Maximum Power Point Tracking (MPPT) Technology allows for self-sustaining energy recharge thereby reducing dependency upon traditional grid based charging infrastructure. Additionally, this product's design complements National Initiatives focused on Accessibility, Equity & Entrepreneurship, as well as Government Support, to ensure its Affordability and Scalability. In summary, this Project represents an environmentally friendly alternative mobility solution, and has potential for expanded use through incorporation of Lightweight Materials, Internet of Things (IoT)-based Diagnostics, and Increased Efficiency of Energy Harvesting via Advanced Solar Energy Systems.

## Acknowledgements

The authors wish to express their appreciation to the Council of Science and Technology (U.P.) India and Dr. Ambedkar Institute of Technology for Divyangjan, U.P. India; whose provision of an educational environment and institutional resources allowed the completion of this research. Grants or funding bodies do not need to be listed as having provided financial assistance during the preparation of this manuscript.

## References

Daryaei, M., Esteki, M., & Khajehoddin, S. A. (2023). High efficiency and full MPPT range partial power processing PV module-integrated converter. IEEE Transactions on Power Electronics, 38(5), 6627–6641. https://doi.org/10.1109/TPEL.2023.3243174

Febritasari, R., & Batan, I. M. L. (2022). Tricycle with an electric drive mechanism for post-stroke rehabilitation. In Recent Advances in Mechanical Engineering (pp. 121–129). Springer. https://doi.org/10.1007/978-981-19-0867-5_15

Fu, W., van Paassen, M. M., & Mulder, M. (2020). Human threshold model for perceiving changes in system dynamics. IEEE Transactions on Human-Machine Systems, 50(5), 444–453. https://doi.org/10.1109/THMS.2020.2989383

Hadiningrat, M. S., et al. (2023). Fabrication of eco-friendly electric tricycles with solar panels for handicapped persons. Gravity: Jurnal Ilmiah Penelitian dan Pembelajaran Fisika, 9(2), 140–147. https://doi.org/10.1063/5.0224518

Jayakumar, M., Prabaka, K., Viji, B., & Raja, M. (2024). Solar powered tricycle for specially abled person. International Journal of Innovative Research in Advanced Engineering, 11(5), 550–553. https://doi.org/10.26562/ijirae.2024.v1105.16

Mohekar, A. A., et al. (2016). Design of an innovative retrofitted tricycle for a disabled person. ResearchGate. https://api.semanticscholar.org/CorpusID:212598666

Nguyen, T. P., Le, H. M., & Do, N. H. (2020). Design of solar-powered tricycle with foldable canopy. International Journal of Transport & Vehicle Engineering, 14(3), 89–93.

Okafor, F. O., & Chukwuma, C. (2018). Design of a solar-powered electric cargo tricycle for disabled persons. Nigerian Journal of Technology, 37(1), 215–222.

Raju, G. S., & Somaiah, A. (2020). Design and development of hand power tricycle for disabled using hand lever and crank system. International Journal of Mechanical Engineering and Technology, 11(2), 92–98. https://iaeme.com/MasterAdmin/Journal_uploads/IJMET/VOLUME_11_ISSUE_2/IJMET_11_02_009.pdf

Schuss, C., Eichberger, B., & Rahkonen, T. (2018). Impact of solar radiation on the output power of moving photovoltaic installations. In IEEE I2MTC. https://doi.org/10.1109/I2MTC.2018.8409696

Umamaheswari, R., et al. (2024). Next-generation transportation: Smart electric tricycle integrated with IoT technology. Engineering Proceedings, 66(1), 34. https://doi.org/10.3390/engproc2024066034

Zhou, L., Chen, M., & Fan, J. (2021). Emotion-aware AI driving assist system for electric tricycles. IEEE Transactions on Human-Machine Systems, 51(4), 299–307.