TEAM PD54

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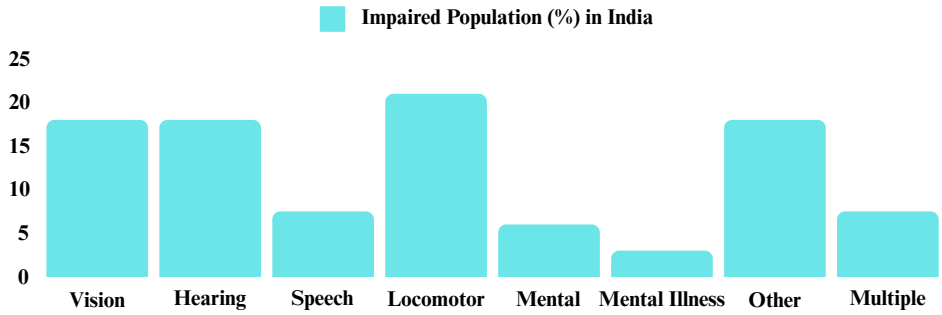
INTRODUCTION

In today's progressive era, where integration and inclusion of all people are emphasized as the gateway toward sustainable development, targeted measures for the health and well-being of people with disabilities are becoming more indispensable. The World Health Organisation estimates that **15% of the world's population has some form of disability**, with o**ver 80% residing in low and middle-income countries**. In the case of India, a country with a population of over 1.36 billion, **more than 2.2% face severe disabilities**. Even in this modern era, the existing solutions aim to just bridge the necessity gap due to disabilities. However, there is still a dire need for solutions to provide a **self-sufficient**, easy-to-use, pleasant experience while using the product. Hence, there is still a lot to be done for disabled people to lead a more trouble-free, comfortable life.

PROBLEM OVERVIEW

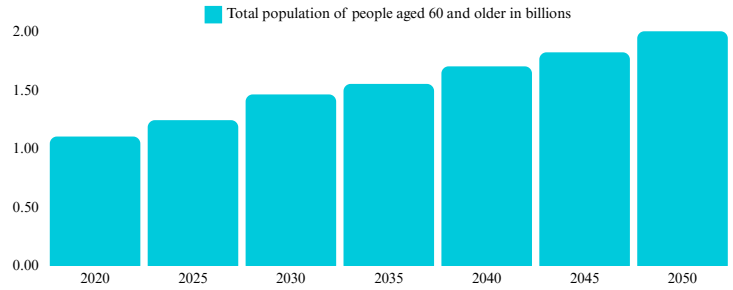
It is estimated that globally, over **650 million people** have disabilities, with motor disability being the second most common yet the most neglected type for special care compared to other impairments. The World Health Organization (WHO) reported that **10% of people with disabilities**, approximately **112 million** people worldwide, need a wheelchair (WC) to enable mobility and social participation. In India, around **10.66 million** people have locomotor disabilities.



Wheelchairs are vital for people with mobility issues, manual ones being most popular for their affordability and simplicity. Despite widespread use, they have fundamental limitations. Users of manual wheelchairs often face difficulties moving due to a lack of upper body strength, leading to dependency on other individuals. Challenges with traveling long distances and inclines hinder independence. One of the major drawbacks is the discomfort caused during transfer to beds or toilets from the wheelchair. Other drawbacks include the absence of emergency features, often needing assistance, and risking injuries.

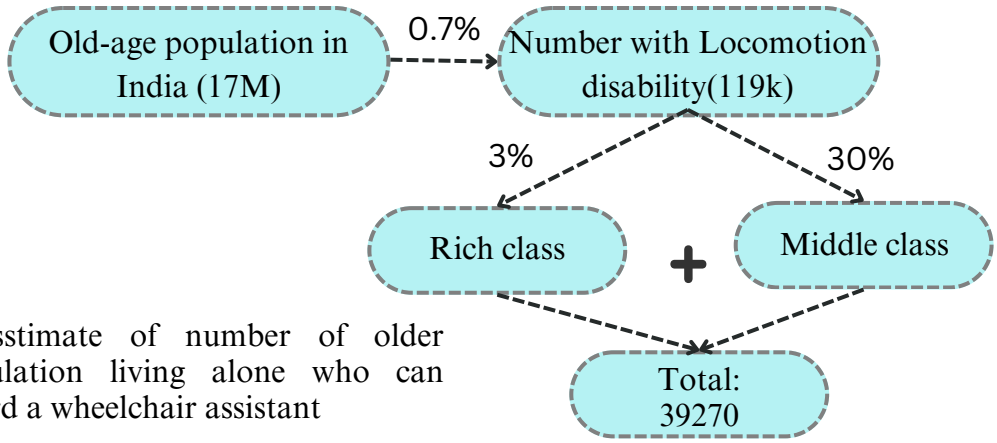
KEY DEMOGRAPHIC TRENDS

Growing Elderly Population Across the World :
The WHO reports that the proportion of the global population over 65 will double from **7% in 2000 to 16% by 2050**. Economic growth in countries such as India creates job opportunities for the young, **leaving the elderly with less familial care**. The difficulty faced by working youth and elderly with **limited upper body strength** in using manual wheelchairs underscores the rising preference for electric wheelchairs. Additionally, with **50 million** people worldwide injured annually in vehicle accidents and nearly **200 million** suffering from significant disabilities, including those with lung and cardiovascular issues who **cannot walk long distances**, the demand for electric wheelchairs is set to increase, highlighting their growing necessity in the global market.



MANUAL WHEELCHAIR ASSITANCE

The number of older adults in India living alone is **17 million**. In India, the percentage of people with locomotion disability is 0.7%. The total number of populations who are old age people living alone in India **capable of having a wheelchair assistant is 5.1 million,** assuming only the upper middle (30%) and rich class (3%) can afford a wheelchair assistant, the number of older adults in India living alone who have locomotion disability is 39270—assuming one wheelchair assistant for each. The total market share of wheelchair assistance in households is 471.24 **million**. The average salary of a wheelchair assistant is **12000 per month**.



Guesstimate of number of older population living alone who can afford a wheelchair assistant

CURRENT SCENARIO

- **Manual wheelchair:** These wheelchairs have adjustable seat heights, folding frames for more accessible transport and storage, and customizable options for added comfort and convenience

- **Stair climbing wheelchairs:** These wheelchairs often utilize advanced sensors and motors to automate the climbing process, potentially offering more user independence and ease of use

- **Off-road wheelchairs:** These wheelchairs are designed for rugged terrain and have features like wider, high-traction tyres, enhanced suspension, and increased ground clearance, allowing users to navigate uneven surfaces, gravel, or even light trails

- **Standing Wheelchair:** These wheelchairs allow users to transition from a seated position to a standing position. This functionality offers increased independence, improved social interaction, and better access to counters and high cabinets. They are particularly beneficial for those who experience health issues from prolonged sitting

Manual Wheelchair

Offroad Wheelchair

Stair Climbing Wheelchair

Standing Wheelchair

Our product overcomes the problems faced by people using these current solutions by making it autonomous and easy to control using joystick.

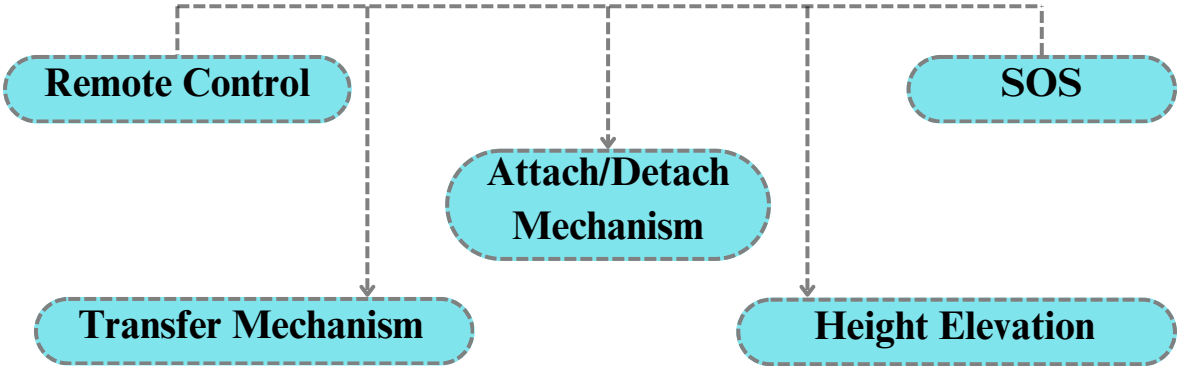
PRODUCT OVERVIEW

Product Summary :

Saarthi is an automatic wheelchair with a joystick for the movement of a wheelchair, augmented with several features like a **transfer mechanism** from the wheelchair to the different platforms, including the most essential ones: bed and toilet. It also has the mechanism of **motorized height adjustments** for transferring the patient to an increased height surface. The wheel also has a lateral movement feature for transfer where the patient can control the amount of movement and unlock the flaps, which will finally transfer the patient. It has several safety features, including an **SOS button** to send emergency alerts to people nearby. It also has additional safety features like seatbelts and calf straps.

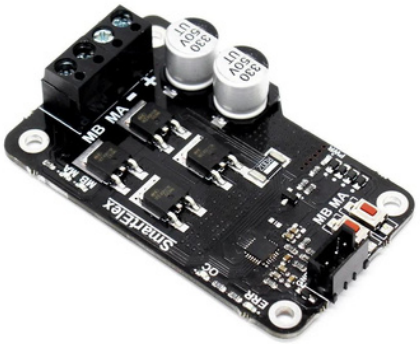
CAD Model of Saarthi

USE CASES



PRODUCT SPECIFICATIONS

Arduino ATmega328P Controller:
ATmega328P is a **high-performance** yet **low-power consumption** 8-bit AVR microcontroller. It reads the handheld joystick inputs, activating the motor for forward and backward movement, braking, and height adjustment

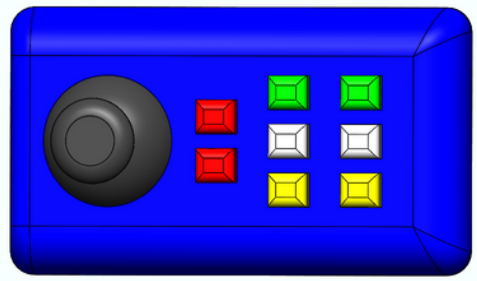


SmartElex 15S DC Motor Driver:
The SmartElex 15S is a powerful motor driver board suitable for Brush DC motors. It is working voltage is **6.8V to 30V DC**. It operates on a continuous current of 15A with a peak current of 30A, and the PMW frequency is up to 20kHz. Its wide operating voltage range and **ease of interfacing with microcontrollers (MCUs)** make it a versatile choice for motor control projects

DC Motors:
Two Robodo MY1016ZL motors of 24 V and output power of 250 W provide an operating speed of **75-120 rpm** at unloaded conditions. These motors are commonly used in electric wheelchairs, ensuring **reliable performance**. Their permanent magnet DC mechanism ensures efficient operation, and they come equipped with an **electromagnetic brake lever for safety** during use

Lithium Ion Battery:
The **two** Li-ion batteries have a capacity of **20 Ah**, each having dimensions of 149 mm x 101 mm x 71 mm and a weight of **1.85kg**. They provide **reliable power for mobility and independence**

Joystick:
Joysticks in wheelchairs act as a **user's control panel**. These joysticks translate user input into signals for the Arduino controller, which then **directs the movement** of the wheelchair



Putter Electric Actuator:
Two robust electric actuators with a **150 kg capacity** each will be used for **vertical movement**. These actuators are designed to lift and lower, ensuring smooth and controlled motion for height adjustments.
Two electric actuators powered by a 12V DC supply will be used for **lateral movement**. These lateral actuators facilitate side-to-side shifts, allowing positioning and maneuverability

Stepper motor:
A stepper motor will be used to open and close the flaps.
Specifications include-

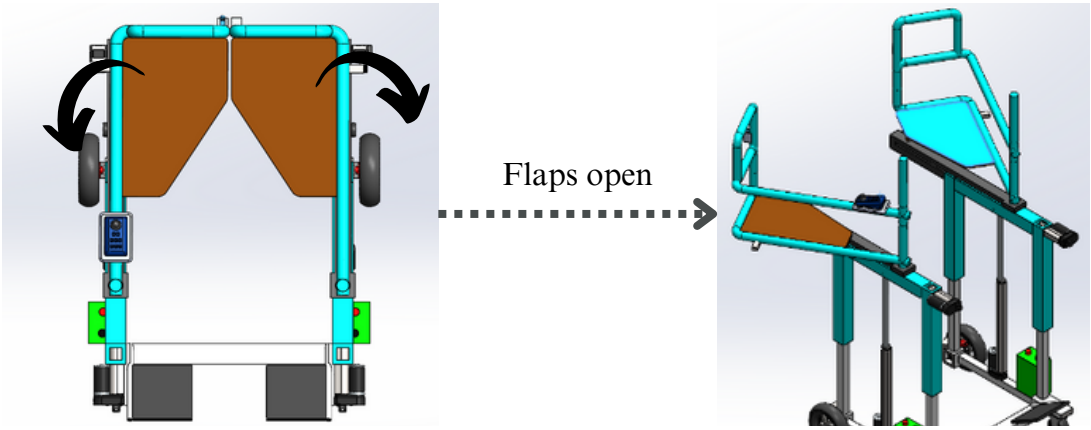
- Rated voltage (v) - 66,
- Current/ phase (a) - 1,
- resistance/ phase (ohms) - 6.6,
- Holding torque (kg-cm) - 7.2,
- NoOf leads - 6,
- Step angle - 18 degrees

Servo motors:
One servo motor is required for the flaps' locking system.

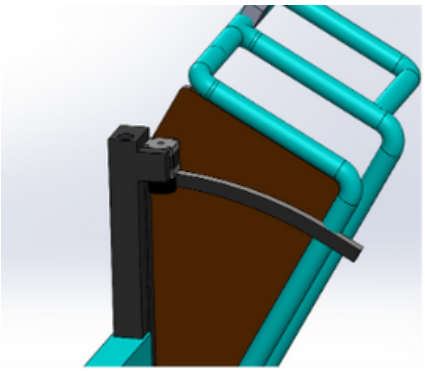
- Voltage 4.8 Volts
- Product Dimensions 13W x 30H Mm
- Material Nylon
- Item Weight - 150 Grams

PRODUCT FEATURES

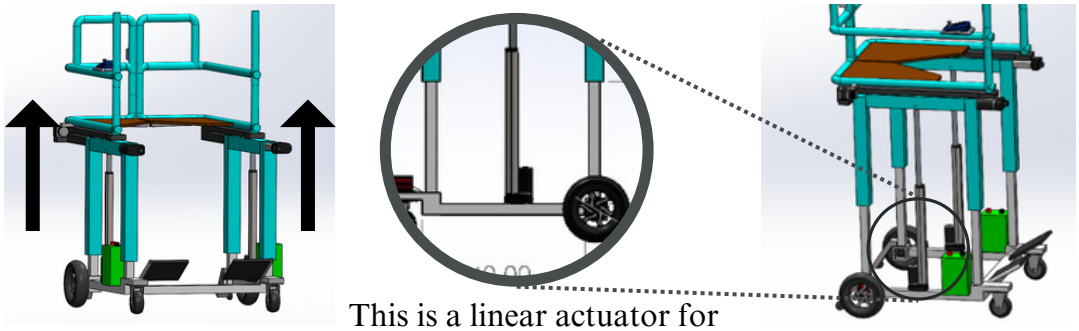
1. Transfer Mechanism from one seat to another: Innovative design easily transfers patients from their beds to the bathroom/chair.



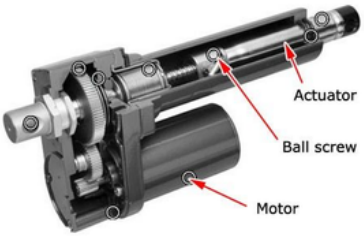
Flaps opening mechanism:
Two stepper motors are used at the end of horizontal rods. Curved beams at each part support the bottom part of the seat. Beams touch the top part of the stepper motor. When we instruct to **open the flaps**, the stepper motor rotates anticlockwise, and due to friction, the beams start traveling outwards. Similarly, the stepper motor rotates clockwise to **close the flaps**, and the beams start moving inwards. Thus, the half seat opens and closes through this mechanism.



2. Height Adjustment: The wheelchair is **designed to raise or lower the transfer seat** to lift patients gradually from any position to ensure safety and comfort. Seat height is adjustable to suit the bed, chair, or toilet.

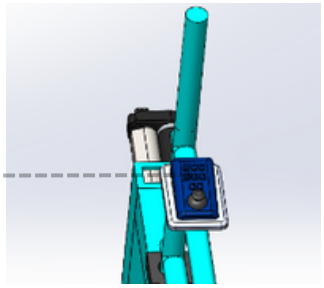


Linear Actuator mechanism:
A linear actuator, powered by an electric motor and screw mechanism, transforms rotary motion into linear motion. It precisely moves objects along a straight path, ensuring accuracy and repeatability as needed. It is essential for systems requiring linear, rather than rotary, movement of payloads.

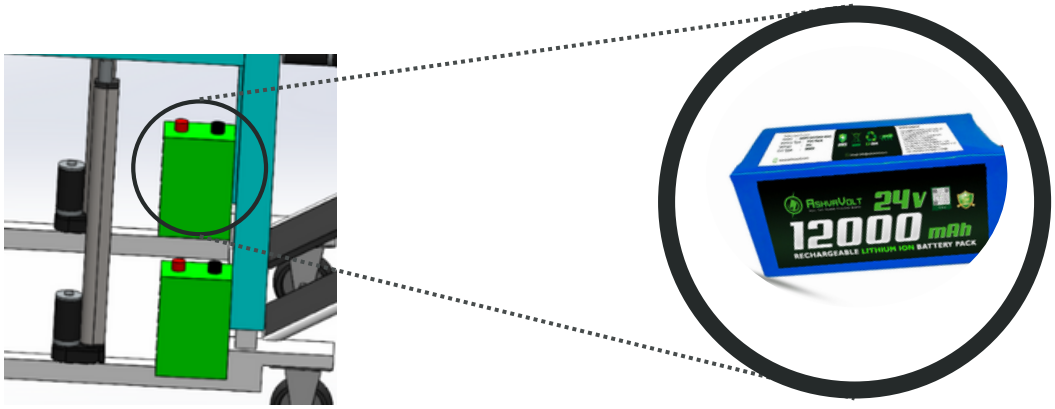


3. Locomotion (Joystick Controlled): With the controller, motor, and battery pack, the wheelchair can be moved electrically from one place to another. The joystick module serves to regulate the direction of motion of electric wheelchairs. Users control the joystick using their hands/fingers.

Joystick at the armrest to move the wheelchair

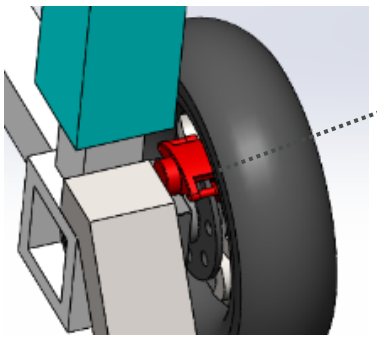


4. Long range on a single charge: The battery pack used in the wheelchair system can last for **10 km** on a single go.



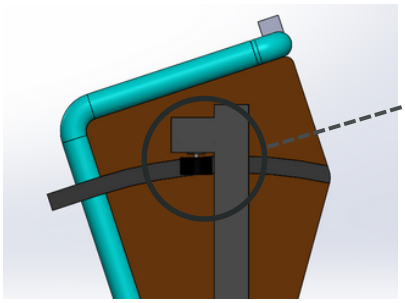
5. Lateral movement of seat of the wheelchair: We are using **two linear actuators** at the seat for the horizontal movement.

6. Lockable wheels: Provision for **anchoring** to place provides more stability and control for the user.



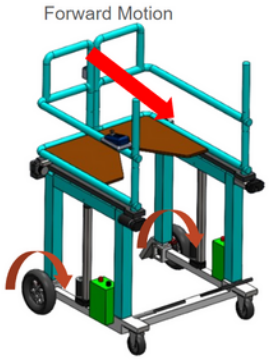
Disc brakes at the rear wheels allow the chair to stand stationary at a place providing ease of locomotion

7. Movement of chair: Servo motors are strategically positioned to minimize torque and strain on motors. This arrangement enhances mechanical efficiency and lowers power consumption. Additionally, half seats are balanced at two points for proper functioning, and ball bearings minimize friction.

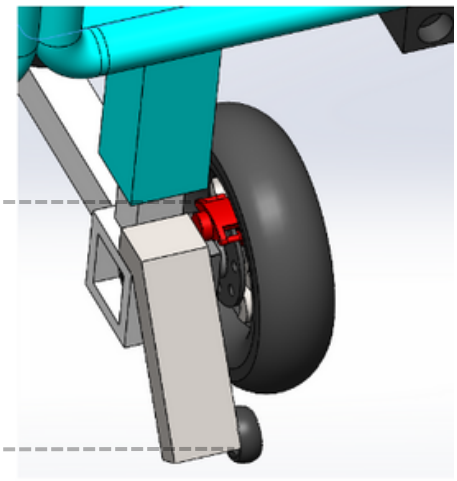


The gliding mechanism provides fluid movement while flap motion and support when the person is seated by giving an opposing torque

8. Rear Wheel Drive: The wheelchair features two rear wheels connected to DC motors and two front wheels. Joystick inputs are processed by an Arduino, which controls the rear wheels. Both motors rotate in the same direction for forward and backward commands. For left turns, the right wheel rotates clockwise while the left one rotates in the opposite direction, and for right turns, the opposite occurs.



9. Braking system: Disc brakes are used at the rear wheels to stop the wheelchair**.**

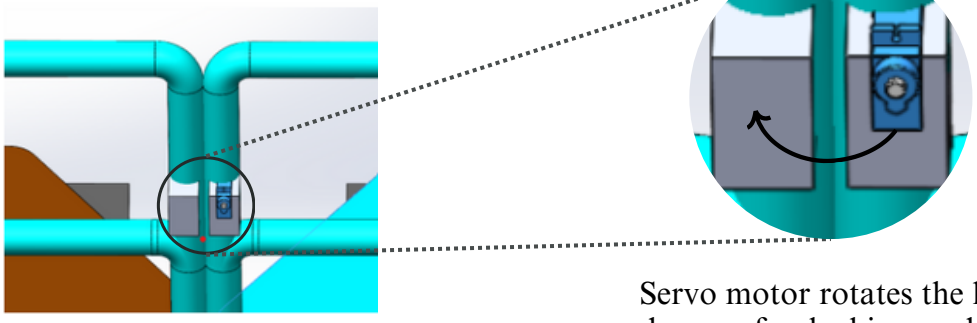


Disc brakes at the rear wheels

10. Anti-tippers wheel: These are used to make the wheelchair toppling-free.

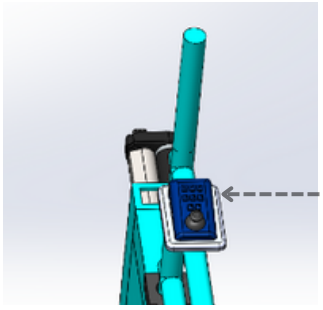
Anti tipper wheels at the rear wheels

11. Locking system of flaps: The Servo motor rotates the hook 90 degrees for locking and unlocking.



Servo motor rotates the hook 90 degrees for locking and reverse for unlocking

12. SOS: The Wheelchair comes with an alert system that notifies persons near the proximity of the accident, family members and the nearest hospital using a GPS tracker.



This is the SOS button will be used in case of an emergency

COMPETITIVE ANALYSIS

Products / Metrics	Standing Powered Wheelchair	Vissco Zip Lite Power Wheelchair	ARCATRON FSS100 Foldable Wheelchair	Saarthi
Controlling	Automatic controlling using Joystick	Automatic controlling using Joystick	Manual controlling requires a third person	Automatic controlling using Joystick
Power	Li-ion battery	Double lead-acid battery	No power	Li-ion battery
Safety	Double safety buckle	Fire retardant upholstery, calf strap	8-inch Front Castor Wheels to clear obstacles	Calf strap and buckling at the seat. GPS tracker, SOS.
Load bearing capacity	100Kg	100 Kg	100 Kg	150 Kg
Additional Features	Rigid	Foldable	Foldable	Rigid
Price	220,000.00	60439	6500	50,000
				

COST ANALYSIS

S no.	Components	Quantity	Price
1	Arduino ATMega328P Controller	1	245
2	SmartElex 15S DC Motor drive	1	900
3	Robodo MY1016ZL DC motors	2	9200
4	Stepper motor (JK57HS51-2804 NEMA23 10.1 kg-cm)	2	3000
5	Lithium Ion battery	2	12000
6	Servo Motor OT5116M 6V 15kg.cm	2	2100
7	Remote controller (Joystick)	1	500
8	Stroke Length DC12V 300MM 12MM/ 350N Putter Electric Linear Actuator (dimensions 40x7.6x3.8)	4	13952
9	Miscellaneous (frame/paint/bolts) + Charging		7000
10	Bluetooth receiver (7CH 40MHZ Remote Transmitter)	1	380
	Net Cost		49277

Government Subsidies :

1. ADIP Scheme (Assistance to Disabled Persons):
Offers a free assistive device, including wheelchairs or tricycles, to people with at least 40% disability and a monthly household income of less than INR 15,000. The subsidy is Rs 50,000 and is provided once every five years. The minimum age to avail of the subsidy is 16 years.

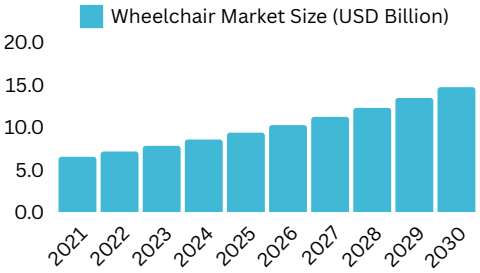
2. AFFDF (Armed Forces Flag Day Fund):
Provides up to a maximum of Rs 1 lakh per ESM who are disabled after their service with disability of 50% or more.

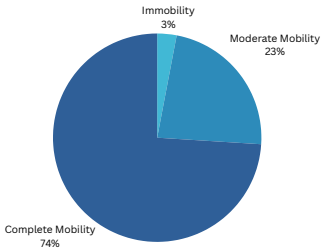
3. Seniors Mobility and Enabling Fund
Offers subsidies of up to 90% for the cost of the mobility aid or 90% of the maximum device subsidy cap, whichever is lower.

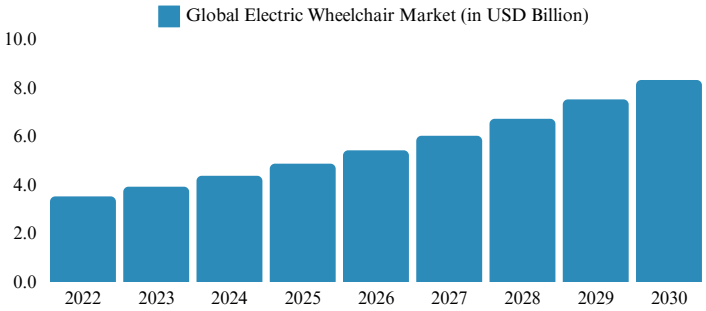
4. Rashtriya Vayoshri Yojana
Offers free distribution of devices commensurate with the extent of disability/infirmity that is manifested among eligible senior citizens.

FINANCIAL OPPORTUNITY

The global wheelchair market, valued at USD 4.8 billion in 2022, is expected to reach **USD 8.4 billion by 2030**, with electric wheelchairs representing a significant segment. Powered by electric motors and featuring user-friendly interfaces like joysticks or control panels, electric wheelchairs offer enhanced independence and comfort to individuals with limited physical abilities. Sales of electric wheelchairs surged to nearly **2 million units globally in 2020 alone**, driven by factors such as the rise in the aging population and increasing injuries requiring mobility support. This growth underscores the importance of electric wheelchairs as a specific segment within the market for mobility products, addressing the diverse needs of over one billion people living with disabilities worldwide.



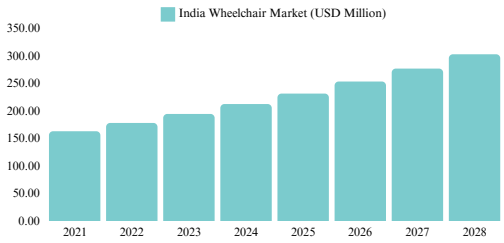




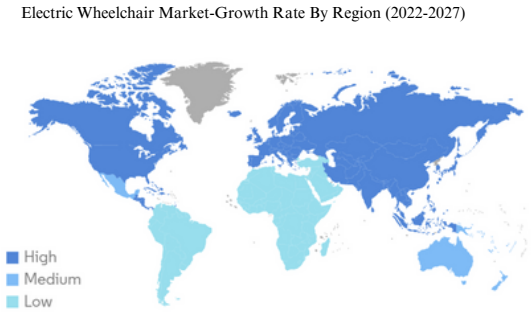
Therefore, this expansion in the electric wheelchair market within the overarching rising wheelchair market marks a **positive trend** for our product in terms of financial prospects.

INDIAN WHEELCHAIR MARKET

India's wheelchair market, valued at **USD 162.58 million in 2021**, is forecasted to grow to **USD 302.41 million by 2028**, with a **9.5% CAGR**. Government initiatives and rising consumer awareness will drive demand.



India **sells about 300,000 wheelchairs annually**, mostly imported and not customized. With 2% of its 1.40 billion population living with disabilities and **30% requiring mobility aid**, India is a significant market player. The country leads in road accidents, with 422,659 incidents in 2021, resulting in 155,000 deaths and 371,000 injuries, driving demand for electric wheelchairs.



Government initiatives and increasing consumer awareness are driving this growth. Under the Make in India campaign, local manufacturers get loan advantages, whereas **financial assistance** is given to low-income families for assistance devices like wheelchairs. Several acts also mandate public buildings, offices, hospitals, schools, etc., to be equipped with wheelchair facilities.

SOCIAL IMPACTS

In India, **10.66 million people with locomotor disabilities** face difficulties in self-care (57%) and interpersonal communication (63%), leading to dependency on caregivers and feelings of loneliness (38.6%).

- **Enhanced Independence and Autonomy:**
  - **Psychosocial Impact:** Users gain a sense of independence and control over their mobility, leading to improved self-esteem and mental well-being
  - **Social Aspect:** Increased independence allows wheelchair users to participate more actively in daily life, social events, and community activities

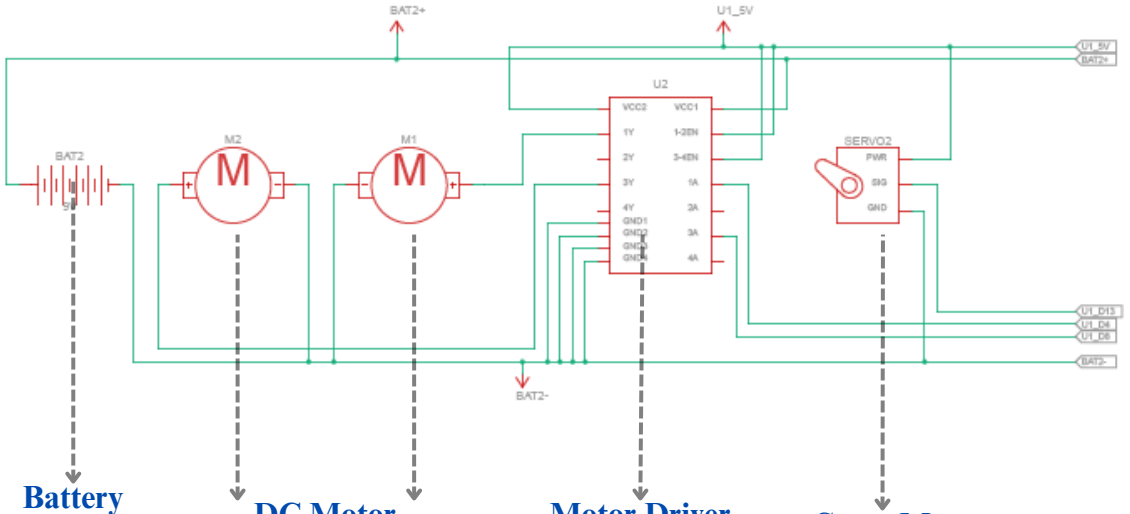
- **Improved Social Participation:**
  - **Psychosocial Impact:** Automatic wheelchairs enable smoother transitions between environments (e.g., home, work, public spaces). This positively affects social interactions and reduces feelings of isolation
  - **Social Aspect:** Users can engage in social gatherings, visit friends and family, and attend community events more easily

- **Reduced Stigma and Social Perception:**
  - **Psychosocial Impact:** Traditional manual wheelchairs may carry a stigma or be associated with limitations. Automatic wheelchairs normalize mobility aids and reduce negative perceptions
  - **Social Aspect:** Society becomes more inclusive and accepting of people with disabilities

- **Health and Well-Being:**
  - **Psychosocial Impact:** Improved mobility contributes to better physical health, positively affecting mental health
  - **Social Aspect:** Healthier individuals can actively participate in work, education, and social life

- **Economic Empowerment:**
  - **Psychosocial Impact:** Users gain confidence in their ability to contribute to society
  - **Social Aspect:** Employment opportunities increase, leading to financial independence and reduced reliance on social support systems

ELECTRONIC CIRCUIT

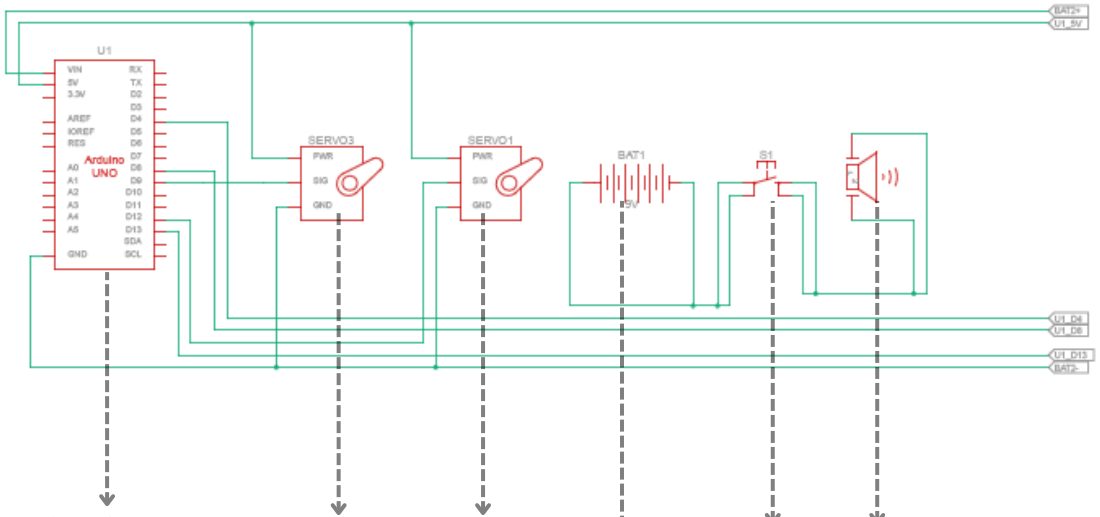


Battery

DC Motor
It is used for rotating the rear wheel of the wheelchair

Motor Driver
It takes the input from Arduino and give instruction to the dc motor

Servo Motor
It is used for locking the flaps



Arduino
It is a processing unit which takes input, processes and forward the command to different components

Stepper Motor
It is used to open and close the flaps

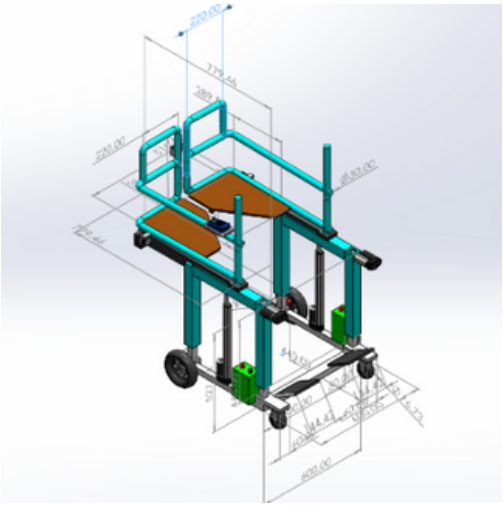
Battery

Switch

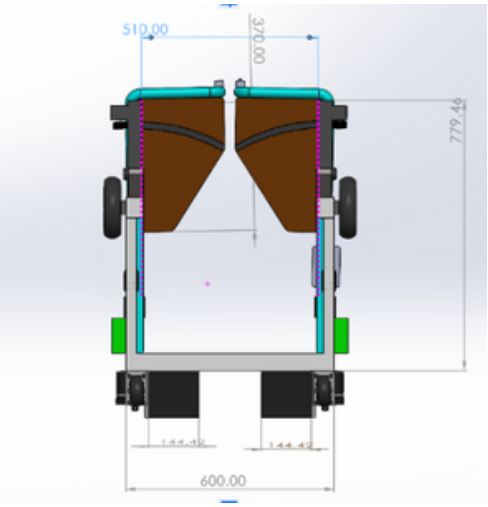
Buzzer
It triggers when someone presses SOS button

ANNEXURE

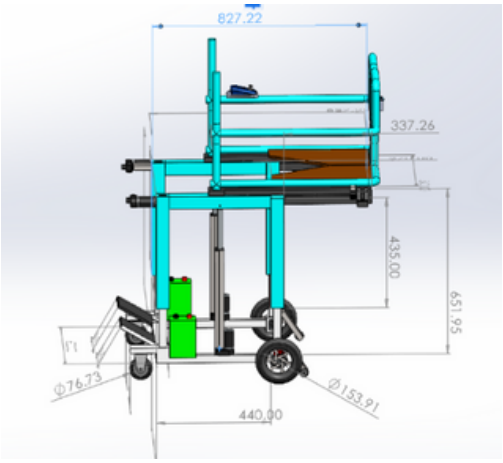
Different Views of CAD Model



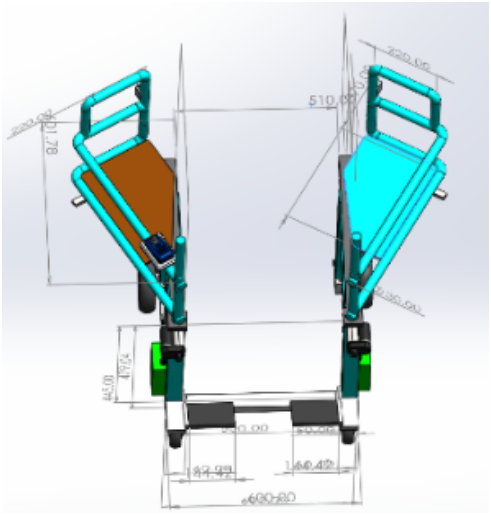
Orthogonal View



Top View



Side View



Open Flaps View

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Range Calculation :

Motor specification:

Rated power..... 250 W
Voltage..... 24 V
Rated speed..... 120 RPM

Battery specification:

Battery capacity..... 12 Ah
Voltage..... 24 V

Total energy = 24 V x 12 Ah=288 V Ah

Speed of wheelchair =Perimeter of wheel x RPM=(Pi x Diameter x RPM)/60)
=(3.14 x 15.39 x 0.01 x 120)/60 = 1 m/s.

Power requirement for the wheelchair per motor=312.5 W

=> Total running time of motors = 288/312 =1 hr =3600 sec approximately.

Average range of wheelchair = running time x speed of wheelchair = 3.5 Km

After considering the losses like friction the average range of wheelchair can be assumed to be around 3 km.