DESIGN OF ACTIVE WHEELCHAIR AND DETACHABLE E-HAND BIKE ATTACHMENT FOR WHEELCHAIR

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Abstract - Human beings who belong to 0.01% of the total animal population of the world, [1] are the most evolved species of the animal family. A certain part of this species is not able to do or learn the most basic things such as walking, running, brushing teeth etc. that a normal human being does independently, this part of the species is, known as disabled human beings. In the early days, they were leading their lives highly dependent on others and hence they were under looked by many people because of this fact. As time progressed and the science and environment in which we live evolved some many inventions and discoveries took place to help this set of people to be independent as much as possible and feel that even they are equal to the other people around them. One invention that helped these people in their mobility was a Wheelchair in the year 1783. Though there were many advancements to date, there were many problems that are not addressed in a general orthopedic wheelchair. Some problems like pain in the back, spinal cord injuries, pressure sores etc. are not at all solved. Hence to solve this problem we are making an active wheelchair that is electrically driven. This is because the cost of an active wheelchair in India at present is around US$1400-US$3500, which is impossible for a middle-class Indian to afford. Hence to reduce the cost we wish to develop this wheelchair in India and make it affordable to the common man. In addition, we try to add an E bike to this so that the wheelchair is mostly used by the person itself.

Keywords – Sports Wheelchair, Active Wheelchair, Fabrication, Stress, E-hand Bike, Axial Pin, Assembly.

I. INTRODUCTION

Wheelchairs are one of the handiest and extensively used kinds of clinical help gadgets today. They are utilized in hospitals, retirement houses and Sports as well they are either electric or guide powered. They are made for interior or outdoors, and there are infinite customizable capabilities that will let you pick an appropriate wheelchair configuration to satisfy you‘re purposeful and luxury needs. Wheelchairs have come in a protracted manner because of first iterations. There is uncertainty approximately whilst the primary wheelchair changed into invented and who invented it. ―It is unsure as to what may be taken into consideration the primary wheelchair, or who invented it. The first acknowledged devoted wheelchair (invented in 1595 and referred to as an invalid‘s chair) changed into made for Phillip II of Spain through an unknown inventor. Stephen Farfler, a paraplegic watchmaker, built a three-wheeled self-propelling chair in 1655,‖ writes Mary Bellis on Thoughts. [2]

II. WHAT IS AN ACTIVE WHEELCHAIR

Disabled (and, frequently, different participating) athletes use streamlined recreation wheelchairs for disabled sports activities that require speed and agility, along with basketball, rugby, tennis, and racing. Each wheelchair‘s recreation tends to apply precise kinds of wheelchairs, and those do not look

like their ordinary cousins. They are commonly non-folding (to growth solidity), with a reported perspective for the wheels (which provides balance during a pointy turn) and fabricated from composite, lightweight materials. Sport wheelchairs are not typically for ordinary use and are frequently a _second‘ chair particularly for carrying usage, even though some customers choose the game alternatives for each day.

A game wheelchair could be very one of a kind than awell-known wheelchair. To facilitate a game hobby for his or her users, the ones unique wheelchairs have:

- A shorter seat, without a headrest or armrest topermit ease of movement.
- Tailored tires
- Willing wheels
- A strengthened body
- A reclining seat
- Cricket wheelchair is an energetic mild weight wheelchair designed and evolved for a participant taking all attention like participant state, posture, weight, pan of utilization etc.

The tires, wheels, axles, casters, leg rests, and armrests are the most important components of a sports activity wheelchair.

Frame: The body is the maximum primary unit of a guide wheelchair and the maximum influence in

phrases of performance. However, the additives which are connected to the body to generate a purposeful guide wheelchair are widespread as well. b. Rear wheels and tires: The wheels are commonly spoked (wired) or molded (magazine). Wheel sizes commonly variety from approximately 30 to sixty-six cm (12 to 26 inches) in diameter, relying upon the cause of the wheelchair. Melded wheels are easier to maintain.

Wheelchair tires are both stable rubber and pneumatic (air-filled). Solid rubber tires are nearly usually used with well-known wheelchairs and occasionally with lightweight wheelchairs. Those tires offer a tough experience and feature an excessive rolling resistance; however, they have got low put on costs and are low renovation Pneumatic tires are almost always found in ultralight wheelchairs. Axles: Rear-wheel axles are both constant and quick-launch. Fixed axles are nearly usually used on well-known wheelchairs. Quick-launch axles are nearly usually used with ultralight wheelchairs. A quick-launch mechanism has a button at the quilt of the axle that lets in for smooth elimination of the tire with no tools. This is useful for disassembling a wheelchair before moving it in a car. d. Casters: The casters variety in length from approximately 7.6cm to 23cm (three to nine inches) in diameter. The caster tires may be stable rubber or pneumatic however are restricted to both magazine and stable hub wheels. e. Leg Rest: The caster tires may be stable rubber or pneumatic, however, are restricted to both magazine and stable hub wheels. Fixed leg relaxation is fundamental to the body; they produce a lighter-weight machine in view that there are fewer additives. f. Seat and Cushions: The maximum not unusual place kinds of the seat base are sling seats and stable seat. Sling seats (additionally referred to as slung seats) are made from a bendy fabric consisting of canvas or vinyl.

An insufficient stress-remedy cushion is the only thing of a wheelchair this is maximum probably to motive stress sores, critical harm, or untimely death. Wheelchair cushions are used for 3 reasons: comfort, stress remedy and postural support.

III. WHY DO WE NEED MORE WHEELCHAIR ATTACHMENTS

As you possibly recognize its miles usually the small caster wheels which purpose the issues – if there may be a few gravels or a divot on the street then your caster wheels will discover it! With a wheelchair electric powered hand motor motorcycle attachment, you could be snug that this may now no longer be a problem and you will be capable of recover from any terrain with ease. Sometimes you simply want that little more energy that is why a wheelchair electric powered motor motorcycle attachment is a first-rate piece of equipment. The manner they paintings is that they connect to the front of your wheelchair without problems and securely after which elevate your caster wheels off the floor, which means all the weight is then at the front wheel that is wherein the energy is.
E-Bike encompasses additives like: Hub motor, electronic velocity controller, Battery, throttle, and brakes in Electric Domain. In the mechanical area, it encompasses Handlebar, Headtube, fork and steerer.

IV. AIM AND OBJECTIVE

The main objective of this project is to develop a wheelchair that is used specifically for cricket person as well as which can be used by a common disabled person who is active in his daily life also to get access to an affordable active wheelchair. Other specific objectives are:

- To help a disabled player to maintain his health and safety.
- To strengthen and increase the durability of the product using alloy material to manufacture it.
- Suitability for the player.
- As per the rulebook by the wheelchair cricket association, a player cannot use any electric transmission vehicle for mobility on the field, but we are planning to use this detachable electric hand bike for the common people scenario.

V. LITERATURE REVIEW

Before making the final decision regarding the choice of the major project, brief research was conducted to find out the projects done previously on the related topic following our investigation, we concluded that a wheelchair is a chair with wheels designed to substitute walking for disabled persons. It is the replacement of legs for physically challenged adults, the elderly, and youngsters who are unable to walk due to birth or other mishaps. This gadget is available in a variety of configurations, including self-operated, electrically operated, and with the assistance of another human. Electrically operated wheelchairs are used for peoples who require travelling for long distances which difficult to self-operate and operated with the help of another person to push. These wheelchairs are not only used for traditional mobility but also for cardiovascular patients.

There are several sorts of wheelchairs; we distinguish them based on the mode of power used to propel them. These wheelchairs are differentiated into two main types as below: Manual wheelchair, Electric powered wheelchair Manual wheelchairs use manpower as a source of energy to move the chair; they can be controlled by themselves or with the assistance of another person. The self-operated wheelchairs are propelled by the back wheels (diameter 24 inches), which resemble bicycle wheels

but have an additional rim known as the hand rim, which is used to push the chairs around. To operate manually operated wheelchairs high Strength is required or the user needs to depend on someone else to Push the Chair to achieve the movement. It cannot be utilized for long-distance movements, and it gets caught in tall grass and dirt quickly. Muscle tension, the density of the bones deteriorates. Most of the time, your blood pressure is out of whack. Blood clots can occur due to a lack of blood circulation, and there is no self-body temperature regulation in this sort of wheelchair, which is solely for those who are handicapped by their legs. [3]. A person who is fully handicapped cannot use this wheelchair.

For fully handicapped persons electrically operated wheelchair is a solution. The wheelchair that is powered by an electric motor is referred to as an electrically operated wheelchair. This wheelchair requires navigational controls, which are often a small joystick positioned on the armrest to control the chair's movement [4]. Head switches and chin-operated joysticks are available for individuals who are unable to handle a manual joystick; additional specialty controls may also be available other specialist controls may be given for independent wheelchair operation [2]. The most popular type of controller is an armrest-mounted joystick with extra controls that allow the user to customize sensitivity or access numerous control modes. To aid with side-transfers, the controller can be swung away Users who are unable to utilize a hand controller have a variety of options, such as sip-and-puff controllers, which work by blowing into a sensor [5]. The controller may be installed so that an assist strolling behind the chair can use it instead of the user [6]. In the case of an electrically operated wheelchair turning are achieved by turning one drive wheel forward while the other goes backwards, this leads to turning the wheelchair within its length as per the requirements of the wheelchair user. To control the movement of the wheelchair Mechanical brake is used for braking so friction losses are more, Hence Frequent replacement of brush shoe is required [7].
The relationship between components of vehicle mechanics and the user's physical condition is the subject of wheelchair ergonomics research [8]. Longer use of an ergonomically built wheelchair will result in less strain. Ergonomics in a wheelchair considers four key criteria‘s they are force, repetition, duration, and posture. Ergonomics is used for designing the seat for both males and females, ergonomics standard data is used for determining the shape and size of a seat. The standard seat width for 95 per cent of male and females is 449 to 529mm, with a combined 95th percentile value of 479mm for general-purpose seat design, according to ergonomics [9]. After careful research, it is found that presently, there is no instinctive, reasonably priced, and an operational wheelchair is available in the market.

There is a high need and demand for affordable electrically operated wheelchairs design on the considerations of ergonomics standards.

VI. COMPARISON STUDY

We have considered 3 wheelchair company brands.
1. Motivation Multisport wheelchair
2. RGK Elite X Wheelchair
3. Neo-fly sports wheelchair

Motivation Multisport wheelchair
It costs around 1.5 Lakh rupees + Tax and some information compared to our Wheelchair.
Merits:
- It can be used for multisport such as basketball, Volleyball, Rugby etc.
- It is dynamically more stability as it has camber angle of 15^0.

De-merits:
- It is not much suitable for cricket as removable toe guard obstructs the player.
- Wheel gets wore and tore in short span.

A. RGK Elite X Wheelchair
It costs around 1.5 Lakh rupees + Tax and some information compared to our Wheelchair.

Merits:
- It is dynamically more stability as it has camber angle of 15^0.
- It is light wheelchair.
- Short backrest

De-merits:
- It can be used for basket-ball sport only.
- It is not much suitable for cricket as removable toe guard obstructs the player.
- Small casters are not suitable for rough terrain.
- Wheel gets wore and tore in short span.
- Cost is also high and not affordable in Indian market.

B. Neofly Wheelchair
It costs around 1.5 Lakh rupees + Tax and some information compared to our Wheelchair.

Merits:
- Wheelchairs are customized according to user.
- Posture fit and Comfort.
- Feel good aesthetics.
- Affordable in Indian Market.

De-merits:
- Less camber angle decreased stability.
- Difficult in transfer into and out of their wheelchair as it has adjustable armrest.
- CG is higher from the ground.

VII. INNOVATIVE AND USEFULNESS

- Camber angle purely designed for cricket sport.
- Stresses while batting which is acting on chair is completely arrested by giving the light weight supports.
- Weight to strength ratio has been increased by changing the material of aluminum with heat treated.
- Maintenance free frictionless bearing and hub mechanism leads to long durability if wheelchairs without AMC (Annual maintenance cost)
- Ergonomics design for seat, knee joint elbow joint is considered, and cushion material is introduced to relives stress on pressure points.
- Cost reduction compared in market and is affordable by any sportsmen.
- Complete wheelchair is manufactured as per NCBI guidelines.
- Our wheelchair will be made according to your body posture that you will be able to sit in the right body posture.
- Our wheelchair is easy to run. In each push, it can cover 3 times more distance.
- Our wheelchair occupies less space which is easier to move in narrow places.
- Our wheelchair comes with cushioning for ease, skincare, and stability in winter.
- Our wheelchair is robust and provides smooth and safe rides for rough terrain.

VIII. DESIGN PROCEDURE

A. Methodology of Developing an active (aka) sports activity Wheelchair.

- As mentioned above the wheelchair designed became for cricket and in ―Wheelchair Cricket Rule Book‖ there are sure policies and policies to be accompanied in designing and customizing a Sports wheelchair for the player.

Wheelchair customers are strongly advocated to be concerned with the layout and choice process. From experience, customers are the maximum informed approximately their personal bodily and social needs.

Step1: Design Brief
It is a quick declaration of the wishes and standards for the wheelchair. These include.

- Environmental constraints (bodily, cultural, social).
- Local manufacturing resources, along with substances and human resources.
- Performance requirements; and
- Target price.

Step 2: Design of Cricket Wheelchair
After the layout quick is written, layout thoughts are advanced and modelled in CAD software. The body is the maximum critical and influential in phrases of performance. For the cricket, wheelchair needs to be modelled in line with the sensible situation and use a e Maneuverability, Seating and Postural aid elements. As mentioned above Wheelchair embody important additives as follows:

Fig: 4.1: The design procedure of the wheelchair

Frame
A body is a structural machine that helps different additives of a bodily production or metallic body that limits the buildings extent. The body changed into designed and modelled in SOLIDWORKS 2020 software. This body is fabricated the use of Aluminum 6063 T6 pipe of outer diameter 25.4 mm and wall thickness of 3mm and Aluminum 6063 T6 pipe of outer diameter 25.4mm and wall thickness of 1.63mm. The homes of Aluminum 6063 T6 is proven in desk 4.1. The layout of the body in figures 4.2 to 4.5

The Frame has a camber perspective given at rear wheel mount of 10 degree. The camber in wheels offers the wheelchair each static balance and Dynamic balance. Camber additionally brings the wheels towards the person and greater in keeping with the customers ahead push stroke, therefore making it less complicated to push. The traction is higher while traversing slopes.

Property	Value	Units
Elastic Modulus	6.9e+10	N/m^2
Poisson's Ratio	0.33	N/A
Shear Modulus	2.58e+10	N/m^2
Mass Density	2700	kg/m^3
Yield Strength	215e+6	N/m^2
Tensile Strength	240e+6	N/m^2

Table 1: properties of the material used.

Fig: 4.2

Fig:4.3

Fig 4.4

Fig: 4.5

- Frame Analysis:

The analysis of the frame was done by using SOLIDWORKS 2020. A load of 1500N was applied on the center of gravity and the deformation was analyzed. The maximum deformation was found to be 0.1mm. The safety factor for both static and fatigue loading were found good enough to sustain the load. The stress safety factor was 7.3, and the fatigue safety factor was 2.6. Maximum deformation was found at the plate on which the seat is being mounted. The maximum main stress theory was used to do the stress analysis. The loading and boundary conditions applied during the analysis is as shown in table 4.2. The results of the analysis are shown in figures 4.6 to figure 4.8 and is tabulated in table 4.3.

Parameter	Condition
Type of element	Tetrahedron element
Boundary Condition	All wheel supports are fixed
Loading Condition	1500N on C. G

Table 2 Loading and Boundary conditions

Parameter	Value	Units
Max Deformation	0.3601	Mm
Factor of Safety	15	NA
Von-mises Stress	3.022 e+07	MPa
Max Strain	2.908 e-04	NA

Table 3 Results

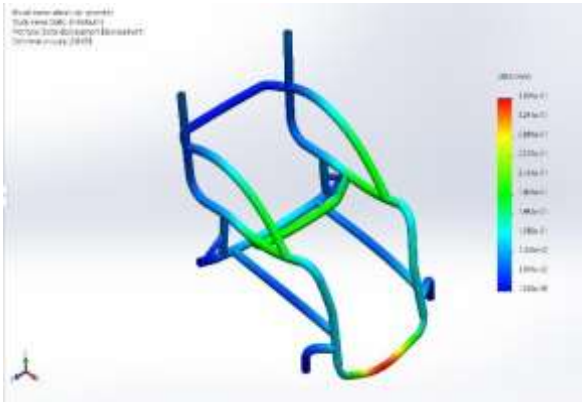

Figure- 4.6 Displacement

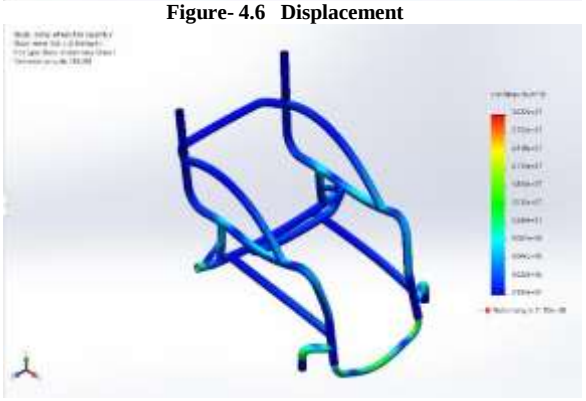

Figure - 4.7 Von mises Stress

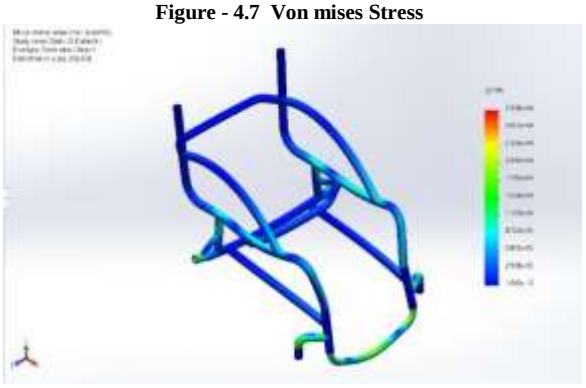

Figure - 4.8 Strain

Axial Pin

The energetic wheelchairs are mild weight and usually a short launch axle pin is used for smooth elimination of wheels. As wheel camber will increase the folded width of the wheelchair will increase, transporting receives extra hard and disposing of rear wheels receives necessary. Also, Rearward stability (resistance to tipping backwards) is tormented by the rear axle role about the customer‘scenter of gravity.

Quick-release wheelchair wheel axle permits for short and smooth elimination of your wheel with the handy push of a button. For a Sports wheelchair, the Axle diameter must be at the least 15mm dia. As proven in discern 4.9.

Step 3: Fabrication

After the Wheelchair being designed, developed, and modelled in SOLIDWORKS CAD software, wheelchair is fabricated in workshop to test the

validity of design and performed the practical testing and user experience.

The pipes are cut to the required length using Power saw and notch cutting is made at the end of the pipe using EDM cutting machine to make an exact fit and to help in welding process. These pipes are bent to required shape with the help of CNC Bending machine. After the bending is done the pipes are washed in chemicals to clean the foreign particles that are present on surface. These foreign particles might induce welding defects such as pores, inclusions, and lack of fusion. The setting is done using jigs and figures for welding process, Using TIG welding torch the pipes are heated using arc that is produced by infusible tungsten- based electrode and the filler metal as a rod is applied manually by welder into the weld pool to weld the frame the welds are then de-burred and cleaned by salts. The frame is ready for the finishing stage i.e., powdering coating and painting.

Before making the final decision regarding the choice of the major project, brief research was conducted to find out the projects done previously on the related topic. After the research, we got the idea that a chair with wheels designed as a replacement for walking for disabled peoples is known as a wheelchair. It is the replacement of legs for physically disabled, elder people, children who have difficulty by birth or any other accidents and are unable to walk. This device comes in many variations like self-operated, electrically operated or with the help of another person to push. Electrically operated wheelchairs are used for peoples who require travelling for long distances which difficult to self-operate and operated with the help of another person to push. These wheelchairs are not only used for traditional mobility but also for cardiovascular patients.

There are various types of wheelchairs, we are differentiating the wheelchair based on the mode of power used for drive. These wheelchairs are differentiated into two main types as below: Manual wheelchair, Electric powered wheelchair. Manual wheelchairs are driven with the help of manpower as a source of energy for moving the chair, these are self-operated or operated with the help of another person to push. The self-operated wheelchairs are driven by using the rear wheels (diameter of 24 inches) which resembles that of the bicycle but has an additional rim known as hand rim are for the movement of the chairs through pushing forward or backwards to get the movement, respectively. The hand rims are of diameter lesser than the rear wheels to get maximum output for minimum input. The use of two-hand rims at a time gives the straight movement of the chair, the use of one of the rims gives the turning movement to the chair towards left or right as per the requirements of the user. To operate manually operated wheelchairs high Strength is required or the user needs to depend on someone else to push the Chair to achieve the movement. It cannot be used for longer distance movements, get bogged/stuck easily in long grass and mud, Strained muscles, Bone density decreases, Blood pressure is almost always out whack, Lack of blood circulation can lead to blood clots, no self-body temperature regulation and this type of wheelchair is only for persons who are handicapped by legs only [10]. A person who is fully handicapped cannot use this wheelchair.

For fully handicapped persons electrically operated wheelchair is a solution. The wheelchair that runs through an Electric motor is known as an electrically operated wheelchair, this wheelchair requires navigational controls, usually, a small joystick mounted on the armrest to control the movement of the chair [11]. For users who cannot manage a manual joystick, head switches are provided, and chin-operated joysticks are provided, other specialist controls may also be provided for independent operation of the wheelchair [11]. The most popular type of controller is an armrest-mounted joystick with extra controls that allow the user to customize sensitivity or access numerous control modes. To aid with side transfers, the controller can be swung away. For users who are unable to use a hand controller various alternative are available such as sip-and-puff controllers, these controls worked by blowing into a sensor [12]. In some cases, the controller may be mounted for use by an aide walking behind the chair rather than by the user [13]. In the case of an electrically operated wheelchair turning are achieved by turning one drive wheel forward while the other goes backwards, this leads to turning the wheelchair within its length as per the requirements of the wheelchair user. To control the movement of the wheelchair Mechanical brake is used for braking so friction losses are more, Hence Frequent replacement of brush shoe is required [14].

The Study of ergonomics of the wheelchair is the interaction concerning aspects of vehicle mechanics and the user's physical condition [15]. An ergonomically designed wheelchair will reduce the strain that is caused due to longer use. Ergonomics in a wheelchair considers four key criteria‘s they are force, repetition, duration, and posture. Ergonomics is used for designing the seat for both males and females, ergonomics standard data is used for determining the shape and size of a seat. According to the ergonomics standard seat width for 95 per cent of male and female are found to be 449 to 529mm and combined 95th percentile value i.e., 479mm for general-purpose seat design [16].no instinctive, reasonably priced, and an operational wheelchair is available in the market. There is a high need and demand for affordable electrically operated

wheelchairs design on the considerations of ergonomics standards.

Step 4: Assembly
After the body is prepared for in addition process, all the spare additives are assembled as proven in parent 3.155. All the spare components are bought inclusive of Tires, Wheels Rim, Caster wheels, Seat, tipping wheels etc. These additives are offered with the aid of using analyzing stresses that is happened for the duration of the dynamic study.

Frame is the number one component and extra additives are linked to this body; the body rear shaft is held with the assist of Plummer Blocks. All the additives are organized and organized to lead them to seen for smooth recognizing. The canvas upholstery is outfitted with the aid of using Velcro, the wheels are outfitted the usage of brief launch axle, the caster wheels are hooked up the usage of fasteners and bolts, the footrest is connected the usage of spring-loaded ball mechanism, the seats are connected the usage of Velcro and tipping wheel set is constant the usage of fasteners.

Fig: 4.10: Full wheelchair

B. Methadology for Designing Detachable e hand bike for wheelchair

Electric hand bike for wheelchair is designed because with a wheelchair electric hand bike attachment, you can be comfortable that this will not be an issue and you will be able to get over any terrain with ease.

Step 1: Design Brief
Design short is a short declaration of the desires and standards for the Detachable Electric Hand motor motorcycle. These include.

- Environmental constraints like hard terrain, indoor feasibility and
- Local manufacturing resources, including substances and human resources
- This E-motor motorcycle is made to run on one hundred upstream slopes.
- The goal rate of the E-motor motorcycle Rs. 25,000

Step 2: Design of Detachable Electric Hand motor motorcycle for Wheelchair

After the layout short is written, layout thoughts are evolved and modelled in CAD software. The manage bar and steerer tube are the maximum essential and influential in phrases of performance. The -motor motorcycle must be modelled consistent with the realistic situation and use i.e., Maneuverability, attitude tilted in the direction of the driver, and the terrain it is going to be driven.

As mentioned above this E-Bike encompasses additives like: Hub motor, electronic velocity controller, Battery, throttle, and brakes in Electric Domain. In the mechanical area, it encompasses Handlebar, Headtube, fork and steerer.

Specification of E- Hand bike:
Total weight of wheelchair- <30kg (Including Hub motor, Wheelchair, batteries)
Frame –1mm thick hallow pipe of stainless steel 304/ aluminum.
Body – 1 mm thick Stain less steel 304 sheetChair.
Following considerations are taken to design it.
Height of the chair: 92cm
Breath of the chair: 50cm
Length of the chair: 70cm
Wheel rim – 304 stainless steels
Front Wheel -- 6-inch diameter
Rare Wheel -- 16-inch diameter
Tire – hard nylon rubber
Seat & Back rest – cushioned foam seat
Brake – mechanically operated disc brake
Motor—300W, 12V brushless motor
Battery: 12V [5]
Battery discharge time – 3 hrs.
Maximum Speed- 25Km/hr.
Maximum distance till battery gets discharge – 20km.
Support heavy load – 100kg [9]

Fig: 4.11: Wheelchair after attaching E-Handling Bike

IX. CONCLUSION

To conclude the research, we finally found that indigenous development of an active sport wheelchair will help the Indian wheelchair market to grow drastically as the price of the wheelchair will reduce too, so that even a middle-class Indian can afford this kind of wheelchair.

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