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DESIGN OPTIMIZATION, FABRICATION AND MANUFACTURING OF WHEEL CHAIR FOR PHYSICALLY HANDICAPPED AND DISABLED PEOPLES AT LOWEST AFFORDABLE PRICE

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Abstract
Across globe of the world and in the country India itself the physically disabled population is more and they needs to depend on other to accomplish daily work. The wheel chair is the way or medium through which the disabled person can perform their task independently. The varieties of wheel chairs are available in market but they are costly or they do possess so operating limitations and disadvantage and that made wheel chair either un-affordable or inconvenient to the peoples. And in the view of this the research work is undertook to design and develop the wheel chair which will be less costly and easy in operation. The proposed model of wheel chair is applicable to the peoples who are at their age 60 or above. The model is also applicable to use by physically challenged peoples though the disability are various types. The problem of wrist pen due to continuous use of joy stick is tried to eliminate in current research work. The proposed model of wheel chair is easy to convert in stretcher/bed and vice versa which eliminates the risk of damage happened when patient may transfer from wheel chair to hospital bed otherwise. The wheel chair serve dual purpose one as a wheel chair and other as a stretcher/bed. In the hospital when scarcity of bed would arrive this wheel chair can be used as a stretcher/bed and will be very beneficial under such circumstances at all.

Key words: Wheel chair, physically disabled etc

1. Introduction: The use of wheel-chair is very common among handicapped and physically disabled person and yet it still depends upon financial status and stability of the one who is looking forward to buy as high cost could make only few to afford it. On an average 35 Thousands to 50 Thousands (Indian Rupees) needs to spend to purchase the chair and thus this left huge mob remains detached from it as they cannot afford it. Most of the old peoples in Canada who faces difficulty in walking in or having movement uses this wheel chair which makes there move independent. The powdered wheel chair cannot be used by handicapped person because difficulty towards its controlling as they moves with high speed and if timely break is not applied that may lead to meet with an accident as handicapped one could not take an immediate control on it due to his/her physical disability. To overcome this problem, IWS (Intellect Wheel Chair System) which has a capability to predict and avoid collision by means of an Anti-collision system. This will be helpful to predict collisions points and hence avoid collisions. Across globe of world approximately 700 million population is handicapped and cannot perform there functions/daily task independently, the figure of handicapped peoples rising day by day in Europe. Under such circumstances offering an independent move to handicapped peoples is very essential from confidence boosting point of view. The assistive robots, human computer interface technology and navigation capabilities are few of those things which can be integrated and make invention possible and will be helpful to design and shape something which would offer further an independent move to handicapped one. Development of IW means development of "User Interface" which will command and control all operations as per the will and comfort of user and responsible in "Independent Move". It may include introduction to, multimodal interface, wheel chair interface centric to user comfort, it also includes joystick which involves lot of wrist movement and thus long use of its causes wrist pain and thus cannot be recommended in longer use. The children's, old peoples and physically disabled peoples will be the beneficiary of such technology. The use of wheel chairs is recommended in hospital, nursing homes, house, pilgrim places, travelling sport and beaches etc. out of the total population of world approximately 15% population is facing disability and there has different types of disabilities. In the context of 15% disability worlds 1 billion peoples are facing disability which won't allow them to perform there routine and essential task independently. Research's says, 1% of the total world's population and 21% population only in India needs the wheel chair to accomplish their work. Approximately 1 crores of male and 60 lakhs female from rural area requires wheel chair support to accomplish the movement and address the task. The calculations in urban areas says, approximately 48 thousands male 29 thousands female are handicapped and facing tremendous difficulty to accomplish and address daily tasks. 69% overall disabled population lives in rural areas, this tells that, 1.86 cores population lives in rural and 0.81 crores population live in urban areas. Before RPWD act passed in 2016 only seven types of disabilities were noted but after the pass of this act this number has rose to twenty one in total. The research and survey also tells that, males are more affected by disability compared to woman. Statics shows that, 52% males and 42% woman are facing seeing disability. In hearing disability this percentage is 53% for male and 47% for female. 56% male and 44% female are facing speech disability. In movement disability this percentage is 62% for male and 38% for female. Mental retardation shows this percentage in male 58% and 42% in female. 58% Males are suffering from mental illness and this percentage for female is 42%. In multiple disability the percentage of male is again high i.e. 55% where in case of female this percentage is 45%. AAI's R & D has undertook project to design of independent wheel chair for handicapped peoples so that

they would no more depends on other to accomplish their daily tasks. The main objective associated with design and fabrication of wheel chair was, reduced cost, less material usage, high efficiency, safety, flexibility, transparency in appearance, extensibility, flexibility etc. the powered wheel chairs are installed with autonomy management system. But cost of designing of this wheel chair goes approximately 35 to 50 thousands which was quite affordable to peoples from all the layers of system. Out of 21% disabled peoples only 10% could buy this chair with cost as just discussed and this quotes the strong need of something which should be affordable and could be reach up to the mass and not up to the specific only.

Toggle switches are used to control the wheel chair and requires more power to operate. Manual wheel chair requires less power to operate.

1.1 Wheel chair components: The wheel chair is generally made of assembly of components can be listed as, suspension system, braking system, controlling and navigation system, flexible seat, power motor, battery, working table, detection system etc. such wheelchair's can be used for multipurpose use and can be used on sandy, muddy roads or for indoor movements also, and only drawback of such types of wheel chair is cost which makes very few to afford it. 20 million peoples are in the need of wheelchair or equivalent support system and only 5% of the total could afford it due to cost and that tell the need to go for cost optimization and design of wheel chair which could perform all task as that of advanced wheelchair and still affordable to all. As an alternative to advanced and costly wheel chair a tricycle has been invented and launched but that was very hard to operate and operator soon starts getting fatigued. Handicapped peoples even can take help of public transportation but that is even very difficult as countries where huge rush is imbibed inside buses or public transportation it would goes very difficult to handicapped peoples to climb and occupy the seats, the similar difficulty he would face while getting down and thus this option is not a feasible deal at all. The current wheel chair model is easy to carry from one place to another, even in rare case it is possible to carry via public transportation also which is not the flexibility in previous models of wheel chairs. It provide total independence and freedom to the handicapped person which is also helpful to boost his confidence level also as he has to depends very less on the other to undertake daily work and he can with little efforts can do on his own.

Fig (1.1.1): Different types of wheel chairs

In the above models of wheel chairs, user gets fatigued after certain distance of drive and thus model design is not perfect from aesthetics point of view. The more efforts are needed to put when wheel chair is need to ride upon muddy and sandy roads, sloppy roads and this makes situation further difficult. The automatic and powered wheel chairs can serve well on such fronts but they cost very high and thus very few could afford it and like

this its benefit could not be reach to mass and needy peoples. Hand Operated Lever Mechanism Wheel Chair and Hand Operated Wheel Chairs are very difficult to operate and causes muscles pain and that further required to take a pause while acquiring any further movement and thus not highly efficient at all. In tri-cycles the one hand is needed to be engaged in operating of wheel and another in controlling of handle and this cases double efforts and pain and situation goes worst when roads conditions are crucial, and thus all these options are outdated and not intended in use nowadays and this quotes the need of something new to invent which will be easy and simple in use and can by at least possible cost. The need of inventing something new can further justify in terms of stats which states that, world 5% population is physically and mentally challenged. 5.6% in Bangladesh is physically disabled and uses clutches or manual wheel chair which is very hard affair and already discussion is happened on same. Most of the wheel chairs invented so far operated by users. The user interface, toggle switch, joy sticks are used to achieve the movement but option is not very much feasible as continuous operating of joy stick causes muscles pain and that further needs to take a pause prior acquiring of any further movement and thus design of wheel chairs are not highly efficient and user friendly. The automated wheel chairs are not affordable and thus use of manual wheel chair is only option left for those who cannot afford the automated wheel chair. In year 1994 MITRE published wheel chair which was an extension to the manual wheel chair and was little advance compared to manual wheel chair and yet performance of it was lying below the advance wheel chair. In year 2012 EMG signal controlled wheel chair was launched which was very much advance version of manual wheel chair and yet it could not meet with performance of advance wheel chair and that was telling further need of design revision. In year 2013, Trivedi launched lap-top assembled wheel chair which was though advance in performance but yet very expensive and not affordable thus. As already discussed joy stick controlled chair is difficult to operate for long time and thus inventions were made with respect to time for vision based EGO system, voice operated based system, voice enabled based system, gesture recognition based wheel chair system, but these inventions were costly again and thus yet replacement to advanced wheel chair at affordable cost could not be done yet or so far move in the research.

2 Literature review and past studies:

1. Mohomad Razali developed the smart wheel chair framework which has manual and semi-automatic control mode which helps to avoid collision and also avoids the needs of continuous monitoring.
2. Raiz-Seran developed the dual control wheel chair model which has a capability of speech recognition for specific time.
3. Alsibai developed the small and smart wheel chair system. The wheel chair system includes human-system interface and navigation techniques. It also consist monitoring and safety system which avoids the continuous monitoring and watch. The only drawback of the system was robustness and safety could not be guaranteed 100%. While designing the chair, health monitoring, muscles relaxation, and rehabilitation tools etc. has been considered.
4. Dual Palpos developed wheelchair for Covid-19 patients by using Nigerian anthropometry data.
5. M K Adegeri done modelling and simulation of wheel chair deputed for handicapped patients. Through simulation he proposed avoiding of material wastage, he used local material in re-modelling of wheel chair and thus reduces the cost further. The wheel chair properties after making use of new material has observed improved. The designed new

wheel chair can be used as a bed and can convert into wheel chair back and vice versa. Average acceleration o chair was 0.10 m/s^2. Vibration dose value noted in between 0.01 to 1.35 and also noted extended up to 1.75 m/s. the noted values for acceleration and for vibration were noted below "Daily exposure action value" and "Daily exposure limit" and thus treated as a safe from safety and operating point of view. Chair to bed and vice versa transformation reduces risk of infection transfer of Covid infected person to other during handling and transporting. The wheel chair has a value 190 US Dollars, the mass production would further reduces it and make affordable to many. The chair has load carrying capacity of 120 kg.

6. Pallavi Chopade worked on wheel chair to address and assist the disability among soldiers. Occupational disability is observed highest among soldiers and this percentage is noted more than 40%. Apart to this to address the problems such as causalities, injuries, hospitalization and permanent disabilities which is very frequent event during was period this wheel chair will be very useful. The major objective of this project work was reduction in medical care cost, rehabilitation efforts, long term disability pay etc. The redesigning is taken place with strict consideration given to ergonomics engineering and safety training.
7. Jesse Hung reviewed past, present and future of the wheel chair. The scientist thoroughly studied smart wheel chair assisted with computers, sensors and assistive technology. The said wheel chair is best and ever capable model to serve the person with all kind of disabilities. The wheel chairs are assisted with head joystick, chin joystick, sip-n-puff, thought control etc. Handicapped person depends on other for, eating, drinking, handling items, communicating with others in large group and this type of wheel chair is an ideal model for the peoples to move from one place to another and perform task independently. Some advanced version of wheel chair designed with seat installed on movable robots as well computer and sensors attached as an additional accessories.
8. Takashi Gomi worked on developing of a smart wheel chair for handicapped peoples. The speciality of wheel chairs designed was it enables to operate on behaviour based approach, establishes on-board autonomy at minimal cost and material usage with good efficiency, safety, transparency, appearance and extendibility etc. Robot assistive system demand leads to increase as peoples with loss of mental control also leads to increased day by day. Behaviour based approach and computer technology is further advance stage in the journey of wheel chair design which replace the robotics assistance and increases the safety margin by great amount. The behaviour based technology enables the recognition of an environment, motion generation, organize the sequence of motion, calculate for kinematics and dynamics etc. design of wheel chair based on behaviour based approach is an advance stage or big achievement in the domain of wheel chair design for handicapped person.
9. Candian wheel chair launched in year 1995 was an ideal example of autonomy management system.
10. Nortan America and Japan design electrical wheel chair for disabled peoples.
11. In year 1995 conference organized on subject/topic intelligent wheel chair design, the wheel chair designed was performed well for 33 days back to back, the research work was taken place for three years to come up with

this real working model. In the wheel chair model microphone recognizes voice and words through voice recognition system and accordingly processor controls the movement of chair by giving command to the motor. Linear motion in all directions are possible through this type of technology implementation. Assembly language programme is stored in controller's memory and execute as according to need. This wheel chair has capacity of carrying person with load 30 kg, speed is 1.2 ft/s. The aim behind developing of this wheel chair was invention of semi-automatic wheel chair to address the mobility goal and present an occurrence of any dangerous system. This is fully motorized toggle wheel chair which is well programmed as well. This is independent, enjoyable, productive types of wheel chair. Wheel chair can converted into bed and hence from bed to wheel chair. It ensures safety. It reduces human efforts while handling.

12. Automatic wheelchair for physically disabled person by Prof. Nipanikar R S developed Ultrasonic and infrared sensors, voice recognition system, integration in wheel chair. Obstacles will be predicted, down holes also be predicted by using sensors. The voice recognition system and hence motion execution. Electronics system configuration. Mechanical model, voice recognition, sensors, accelerometer and joystick, wheelchair is the combination of. Has control and navigation intelligence. Severe impairment people's range of mobility has been increased virtue of this types of wheel chairs. The wheelchair is applicable for person not having hand and leg both, the help required from other peoples to move the wheelchair eliminated totally.
13. Design of voice controlled wheel chair by Ali has Arduino voice controller and speaker dependant voice recognition system, imbedded system, for manual operations. Speaker dependant, isolated word recognition system, definite utterance of aerobic words, to suit patient's requirement demonstrated successfully. Speech processor HM2007, voice recognition, unnecessary sound elimination and isolation used. Doesn't not respond to false responses.14A/24V/200 watt DC motor, clutch, speed reduction gear and locking control etc. used. Arabic words used for operationalization of wheel-chair.
14. Design of voice controlled wheelchair by G Azam has Triggering and controlling the movement of physically challenged people's virtue of voice controlling system imbibing in wheel chair. Microcontroller, microphone, voice recognition processor, motor control interface board responsible in movement of motor and hence controlling the motion associated with it.

3 Research objective: Independent move of handicapped person without taking an assistance from nurses.

4 Problem statement: Design and fabrication of wheel chair,

1. To achieve easiness in patient movement from stretcher to bed and bed to stretcher.
2. Address unsafe condition of the patient.
3. To avoid patient discomfort of seating for long time.

5 Important Design assumptions and calculations:

The distribution of human body weight can be expressed in approximate percentage as, trunk: 48.3% (38.64 kg), head and neck: 7.1% (5.68 kg), thigh: 10.5% (8.4 kg), shank: 4.5% (3.6 kg), foot: 1.5% (1.2 kg), upper arm: 3.3% (2.64 kg), fore arm: 1.9% (1.52 kg), hand: 0.6% (0.48 kg).

- Average weight Wheel chair body, 14.24 kg i.e. 139.532 N.
- Weight of wiper motor = 4.5 kg = 44.1 N.
- Human body weight = 80 kg = 784 N.
- Vertical force = 139.552+784, N.
- Load on each caster = 923.552/2 = 461.71 N.
- Inclination angle = 10 Degrees.
- $F_{Inclined} + F_{Vertical} * (Cos\theta)$ = 923.552*cso (10) = 909.52 N.

For rear wheel calculations are as follows,

- Weight of the body = 14.24 kg = 139.552 N.
- Human weight = 784 N.
- F_{Rear} = (139.552+784) = 923.55 N.
- Weight on each rear wheel is, (923.55/2) = 461.77.
- Force on rear wheel at an inclination of 10 degrees is given as, $(F_{Rear})_{10\_Degree}$ = 923.55 cos (θ) = 923.55 * cos (10) = 909.92 N.
- The force acting on each rare wheel is, (909.92/2) = 454.6 N.

Back rest calculations are as follows,

- Human body weight is = 31.69 kg = 310.91 N
- Maximum inclination angle = 30 degrees
- Back rest weight = 61 kg = 58.8 N
- Force acting, vertical = 310.91 + 58.8 = 369.71 N
- $Force_{Actual}$ = 369.71 sin (θ) = 369.71 sin (30) = 184.855 N

Leg rest calculations are as follows,

- Inclination angle = 55 degrees
- Weight of human leg = 4 kg = 39.2 N
- Vertical force = 39.2 + 39.2 = 79.4 N
- $Force_{Actual}$ = 78.4 sin (θ) = 78.4 sin (55) = 64.22 N

System and its components Description

Table (5.1): Components of wheel chair

Sr. No.	Component	Use/Relevant description
01	Wheels	Conjunction with an axle.
02	Steel pipes	Used for structural applications, made of steel or mild steels.
03	Hinges	Connects two solid objects and allows limited rotary motion. Made of a steel.
04	Bolts and Nuts	Fastening device used to hold two parts together. Formed by forging.

The properties of selected materials are depicted in the table below,

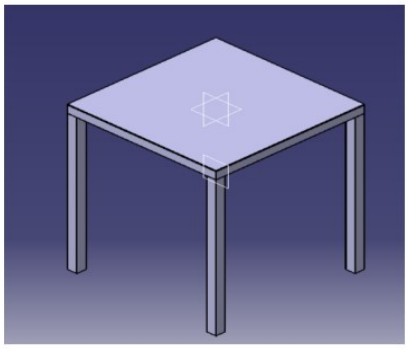
Table (5.2): Material properties of components chose to frame an assembly of wheel chair

Sr. No.	Name of the Property, symbol	Value
1	Density, ρ	7200 kg/m^3
2	Coefficient of thermal expansion, α	10.1 to 16.6 * 1-^06 mm/c^0
3	Modulus of Elasticity, E	68.9 MPa to 2.07 GPa
4	Poisson's Ratio, ϑ	0.23 to 0.3
5	Melting point	1230 to 1530 0_c
6	Ultimate tensile strength, σ_{ut}	450 to 500 MPa

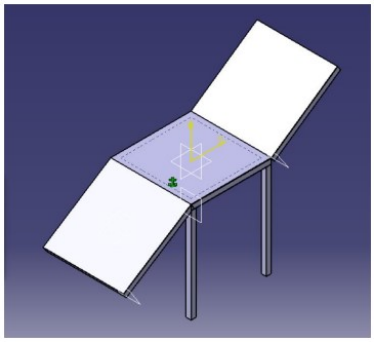
6. Design idea shaping of wheel chair on CATIA: CATIA is product design and development platform, stakeholders and designers can work together while sharing with each other product ideas. The tool is used by original product manufacturer. CATIA can be integrated with other software's such as MS Office, SAP etc. The CATIA can further

integrate with huge platform of product design and development called as PLM. Across an entire network of PLM the design data and product concept can be shared across various user while working on the product and so the inputs received towards product development can be used to reach up to an optimistic product quality. CAD Digital Product Development tools such as CAE, FEA, CNC, Motion simulation, PDM, Documentation, Photo Simulation, can also be integrated across PLM chain to exchange and share the product related data which would speed up the process of product development. The PLM is also useful and capable to retain and retrieve the product related information, parameterization, constraints information, features information, construction history, model personal features, work information related to specific area and also enables user to work on the whole product idea by making use of this information produced and shared from the desk of different users. CAD feature supports stress-strain analysis, time and motion analysis, tensile and yield strength prediction, electrical and electromagnetic analysis etc.

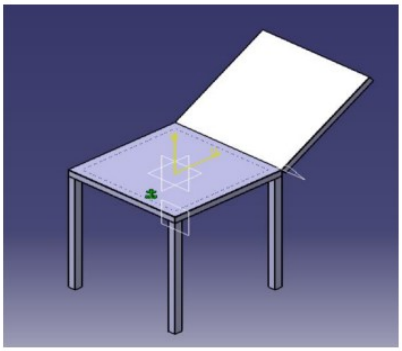
6.1 CAD Model of proposed wheel chair for handicapped:



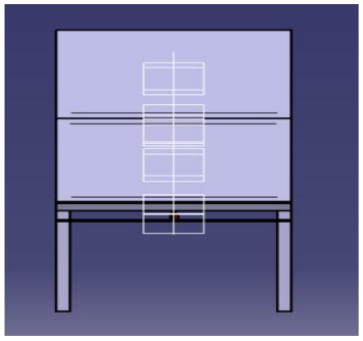
6.1.1. Frame



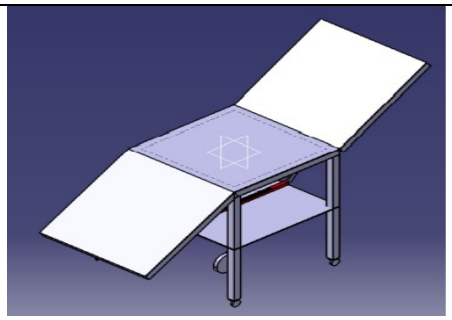
6.1.2 Foot Rest



6.1.3 Head Rest



6.1.4 Front View



6.1.5 Isometric View of the Wheel chair for handicapped person

The frame is extended on one side as head rest and other as foot rest. The wheel chair can be stretched into stretcher or bed and vice versa. This conversion avails the safety to staff and patients both as discussed earlier. During transfer of patent from wheel chair to bed efforts and risk of injury is always there but in the case of this wheel chair the wheel chair itself can convert into long bed and thus need of transfer of patent from chair to bed can be avoided. Thus it reduces risk of disease transmissions which are happened due to contamination. The total length of wheel chair in stretched format is 145 cm, the detailing for same can be stated as, 50 cm for base, 50 cm for lower leg and 45 cm for head rest. This length of chair is enough to accommodate person with high height. The hospital staff needs to carry and transfer the patients for various reasons such as check up's, operation and this leads 38% staff suffer from back injuries and 12% staff suffers from back pain in later part of life, and this can be avoided simply by making the wheel chair as discussed so far.

The design of wheel chair required to take some design properties into considerations such as mechanical, physical and manufacturing. Physical properties include melting point, thermal conductivity, specific heat, specific gravity, thermal expansion, electrical conductivity, magnetic properties weight, surface finish, rigidity, environmental attacks, service life and reliability etc. Mechanical properties includes compression and tensile strength, shear strength , bending and torsion strength, buckling strength, fatigue impact, elastic limit, endurance limit, modulus of elasticity, hardness, wear resistance and sliding properties etc. Manufacturing properties includes cast-ability, weldability, surface properties, shrinkage and deep drawing etc.

7 Gas welding used in wheel chair parts fabrications: Fuel gas and oxygen combination is used to weld and cut the metal in oxyacetylene gas welding. The temperature is approximately 2250 degree kelvin or 19080 degree centigrade or 3590 Fahrenheit. The different combination reveals different results, propane/oxygen flame yields 2526 kelvin or 2253 degree centigrade or 4087 Fahrenheit temperature. Acetylene/oxygen flame yields 3773 kelvin or 3500 degree centigrade or 6332 degree Fahrenheit temperature. Pipes, tubes, repairing work are few of the applications can be accounted as a part of such welding operations.

8 Rack and pinion arrangements: In this arrangement circular gear is engaged with linear gear and hence rotary motion is converted into linear motion. Length of rack is 500 mm, material used is Mild Steel, pinion dimeter is 50 mm, outer diameter is 65.05 mm, teeth length is 7.5 mm and pressure angle/included angle is 11 degrees, thickness of tooth is 2.5 mm, top to bottom distance is 7.5 mm, total teeth engaged are 29.

9 Mechanical assembly: The components of an assembly can be enlisted as wheel, pipe, hinge and bolt etc. few other components also can be listed as rack and pinion, caster wheel, bi-cycle wheel, two way toggle switch etc.

Rack set up equipped with hinged joints and links for the stretcher which enables the conversion of bed into wheel chair and vice versa.

Below portion of chair is connected to the lids, link connected to the bottom and top side is connected to the plate. When pinion rotates bottom plates moves upward and top plate downwards and wheel chair gets convert into stretcher. When, rack rotated clockwise, top plate moves upward and bottom plate moves downward and wheel chair converted into stretcher.

Frame is made of mild steel pipes. Head rest and foot rest are attached to the frame. Hinges are attached in structure to smoothen the operation of folding and unfolding. Nut and bolts are used to attach four wheels to the leg. Motor is attached to the pinion to the center of each leg of the wheel of bicycle. In current application 12 volt battery is used.

9.1 Costing and estimation/BOM (Bill of Material) Table:

9.1.1 BOM Table for wheel chair

Sr. No.	Name of the Part	Quantity	Cost
1	Mild steel material (40*40*15), Square bar	5 kg	400
2	Hinge	02	200
3	Caster wheel	04	2000
4	Link 50 mm, 350 to 500 mm stroke	01	150
5	Motor	01	1800
6	Bi-cycle wheel	02	250
7	Foot rest and heat rest set up	01	1500
8	Fabrication	NA	1500
9	Rack and pinion gear	01	1000
10	Transportation	NA	1000
11	Miscellaneous	NA	500
Total cost			8650/-

9.2 Fabrication of the wheel chair:

9.2.1 Caster Wheel

9.2.2 Steel or mild steel pipes

9.2.3 Hinge

9.2.4 Nut and Bolt

9.2.5 Gas welding set up

9.2.6 Rack and Pinion Mechanism

9.3 Final Wheel chair model after fabrication: The final model of wheel chair will looks like shown as under,

9.3.1 Wheel chair model with base and head rest

9.3.2 Wheel chair model with base, head rest and foot rest

9.3.3 Wheel chair model as a stretcher/bed

10 Testing of Wheel Chair: The following tests have been carried in order to check functionality of the wheel chair,

- Strength test which reveals load carrying of wheel chair is up to 75 kg.
- Operability and easiness in operability of control panel.
- Battery capacity tested for full charging.
- Battery capacity tested for little charged, little slow assistance to control panel.
- Speed, little or average speed model.
- Electric test for electric failure checking and hence accidents going to happen virtue of that.

11 Advantage of the wheel chair model:

- Comfort.
- Avoid damage while transferring/carrying patient.
- No special training is required while handling/operating.
- Most feasible to transfer the patients with serious injuries.
- Efficient and less costly.

12 Limitations of the model: there are following limitations can be accounted for the current model of wheel chair,

- Bluetooth connectivity is not possible for till date model exited.
- The model is not water resistance.
- Model is not fully automatic.
- The model is able to perform back and forth movement only.
- Model has average or less speed.
- Brakes positions are not fixed and thus left very huge scope for assembly alteration which goes difficult every time when need of assembly is firm and fixed.

13 Comparison and advantages of other wheel chair models available in market: Other models of wheel chair available in market has following advantage's which can be consider as limitations of current model of wheel chair, and they are listed as follows,

- Automated braking.
- Speed control.
- Camera mounting.
- Touch-pad.
- Bluetooth.
- Water resistance etc.

Virtue of availability of above functionalities, the wheel chair are very costly i.e. 50 thousands approximately and thus are not affordable. And thus research work is focused on design and development of the wheel chair which will be affordable to mass with assurance given for minimum possible and required feature. There have few similarities between costly model of the wheel chair already available in the market and one which

is focused to develop through current research work and are listed below,

- Can convert into stretcher bed and back into wheel chair.
- Controlling via control panel by patient itself.
- Less cost, affordable to individual and hospital staff, provide convenient of purchase and comfort for use.

14 Needs of improvement/ Future scope and study:

- Stair climbing and self-balancing.
- Battery charging based on solar panel.
- Topology and stress concentration test can enhance/optimize working of battery. Motor and other components functionality can be enhanced in similar way.
- Cost of manufacturing can reduce with upgrading and optimizing some components.

15 Applications of the wheel chair:

- Hospitals.
- Hove's.

16 Conclusion of the Work/Study/Research:

- Semi-automatic wheel chair can be converted into stretcher or bed and vice versa.
- Reduced cost.
- Remote control gives flexibility to operate for different movement without depending on others.
- Reduce or eliminates difficulties of hospital staff while transferring of patient from stretcher to bed and vice versa.

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