

Solar Cart for Street Vendor

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Abstract: Due to urbanization and industrialization there is a rapid acceleration of migration from rural are to urban area. So urban centers are unable to provide employment to all workforce, so they have to find other opportunities for the settlement in informal sector. Within this informal sector, vendors sell their goods in competitive market. Street vendors are often those who are unable to get regular jobs in the remunerative formal sector on account of their low level of education and skills. They try to solve their livelihoods problems through their own meagre financial resource. They are the main distribution channel for a large variety of products of daily consumption like fruits, vegetables, readymade garments, shoes, household gadgets, toys, stationery, newspapers, and magazines and so on.If they were to be eliminated from the urban markets, it would lead to a severe crisis for fruit and vegetable farmers, as well as small scale industries which cannot afford to retail their products through expensive distribution networks in the formal sector.

Keywords: BLDC, PV Cell, Solar

1. INTRODUCTION

Vendors are defined from an economic, cultural and legal position, are those people who offer goods or services for sale from public places, primarily streets and pavements. Street vending is a global phenomenon and the most visible aspect of the informal sector. Street vendors are often those who are unable to get regular jobs in the remunerative formal sector on account of their low level of education and skills. They try to solve their livelihoods problems through their own meagre financial resource. They are the main distribution channel for a large variety of products of daily consumption like fruits, vegetables, readymade garments, shoes, household gadgets, toys, stationery, newspapers, and magazines and so on. If they were to be eliminated from the urban markets, it would lead to a severe crisis for fruit and vegetable farmers, as well as small scale industries which cannot afford to retail their products through expensive distribution networks in the formal sector. The importance of this sector cannot be undermined, especially considering that the government does not have the capacity to provide jobs to the millions of unemployed and underemployed people in India. Even the corporate sector is able to absorb only a tiny proportion of our expanding work force. Overall employment in the formal sector is actually declining. This means most people in India have to fend for themselves. People in the informal sector ought to be encouraged to grow and prosper if the governments want to reduce unemployment and poverty in our country. They contribute significant role in local economic growth and development of the urban economies. Public authorities considered street vendors as a nuisance and as encroachers of sidewalks and pavements and do not appreciate the valuable services that street vendors provide to the general population of the world. Street vendors provide valuable services to the urban masses while making out a living through their own enterprise, limited resources and labor.

By considering all the problem associated with street vendor, we are going to build a street cart that will be operated with the help of solar power and it contains all the basic facilities. It will have seating arrangement, mobile charging and cooling fan. This will improve the live their life with dignity and self-respect through regular vending activities.

2. LITERATURE SURVEY

Street vendors are also termed as street traders, hawkers, sidewalk traders and peddlers. The terms that describe them are based on time or place where they work. Their usages vary according to locality and region. Their terming also differs from state to state and from country to country.

As per the study of street vending by Sharit Bhowmik [1] in seven cities from Mumbai, Ahmedabad, Calcutta, Imphal, Patna, Bhubaneswar and Bangalore. It studied the problems of street vendors in urban areas. It found common features in all the seven cities. The income of the street vendors ranged from Rs. 50-100 for

males and Rs. 35-40 for females. They were persecuted by the municipal authorities and the police. The situation of Patna was worst where bribery was high. The working condition of the hawkers was very poor and most lead a very hard life. They worked for more than 10 hours a day to earn a meagre income.

Jonathan Shapiro Anjaria [2] studied the life of street vendors in Mumbai. It was revealed that in the central districts of Mumbai, many former mill workers and their families have been compelled to take up hawking. Many street hawkers were migrants from rural areas. It was because of ease of entry and the limited requirement of capital, they have entered street vending. It was also because of lack of other employment opportunities, individuals have taken up street vending. Many hawkers make a regular payment to the police and the BMC in the form of money or in kind.

As per the study by Sonawane, S.T. [3] on street vendors of Bengaluru based on 80 street vendors from Lalgagh, Avenue Road, MG Road, Brigade road, Maleeshwaram, Tannery road, Ulsoor lake and CMH road. The study revealed that most of the street vendors belonged to Karnataka. And a few were from TamilNadu, Bihar, Andra Pradesh, Uttar Pradesh and West Bengal. The study also revealed that 40% of the respondents knew at least 2 languages, 56% were from family size with below 5 members, 49% travelled to their work place by bus, 72% spent more than 8 hours at work and many suffered because of increasing pollution in the city. All the street vendors paid bribe regularly.

Ray and Assem Mishra [4] study on street vendors in 23 selected markets within Surat Municipal Corporation. The study revealed that the street vendors in all these cities worked in more or less same situation. It found that street vendors entered into the activity mainly because street vending was their family occupation. They were facing problems of harassment by authorities, problem of eviction and problem of conflict with pedestrians. Most of them did not wish to relocate from original place of vending if they were shifted to nearby places. It was also found that they borrowed money from money lenders on high interest rates for business.

3. SELECTION OF THE COMPONENTS

The different components used are listed below:

- [1] Solar Panel
- [2] Solar Charge controller
- [3] Battery
- [4] DC Motor
- [5] Chain Drive
- [6] Bearing
- [7] Mild Steel Rods

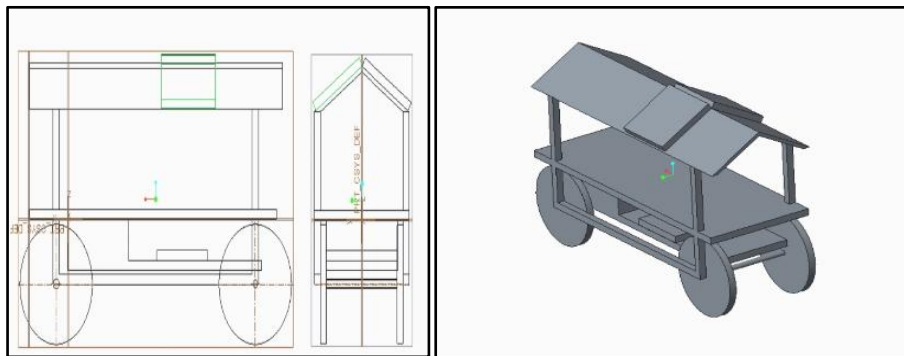


Fig. 1 design of solar cart

Fig. 1 shows the 3D model of solar cart.

3.1 Solar panel

Solar panel works on the principal of photovoltaic (PV) effect. In general, the photovoltaic effect means the generation of a potential difference at the junction of two different materials in response to visible or other radiation. The whole field of solar energy conversion into electricity is therefore denoted as the “photovoltaics”. Photovoltaics literally means “light-electricity”, because “photo” is a stem from the Greek word “phos” meaning light and “Volt” is an abbreviation of Alessandro Volta’s (1745-1827) name who was a pioneer in the study of electricity. A popular and common term to refer to PV solar energy is solar electricity. The sun gives off radiated energy in the form of light photons which is converted into electrical energy by the solar panels. Solar panels are composed of silicon based semiconductors and when the radiation comes in contact with the silicon atoms, the photons are absorbed and the electrons are separated from the rest of the

atoms. These free electrons are responsible for carrying and creating an electrical current. The electricity generated is most usually stored in batteries to be used later. Based on the materials, manufacturing process and their application solar panels are classified into three types, which is shown in fig. 2.

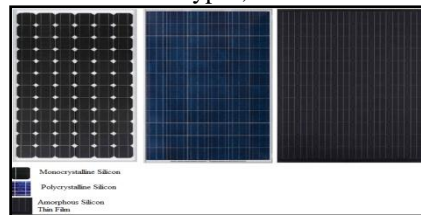


Fig. 2 types of solar panels

Since power generated by solar panel is stored in battery. Vendor, most of the day time is exposed to sunlight, so panel should have capacity to abstract the more amount of light. The space on the roof of cart is also less, by analyzing these thing we should select monocrystalline solar panel. But the cost of the monocrystalline solar panel is very high, this lead to the increase the cost of cart. Thus, we select the polycrystalline silicon solar panel of 120W.

3.2 Solar Charge Controller

Solar power charge controller is used in various sectors. For instance, it can be used in solar home system, Hybrid systems, solar water pump system etc. In this, a solar panel convert's sunlight energy into electrical energy through an electrochemical process also known as photovoltaic process. Energy is stored in the battery with the help of solar panel through a diode and a fuse. Energy stored in the battery can be used when there is no sunlight as during discharge, chemical energy is converted into electrical energy which in turn illuminates electrical appliances. Hence, it is needed to protect battery form overcharge, deep discharging mode while dc loads are used or in under voltage as it is the main component in a solar power charge controller.

For our application we select PV solar charge controller as it is designed for use with all types of 12V photovoltaic panels/systems and different types of 12V batteries, such as wet or sealed lead acid, lead calcium and lead antimony battery.

3.3 Battery

An electrochemical power source or battery is a device which enables the energy liberated in a chemical reaction to be converted directly into electricity. Batteries fulfill two main functions, they are portable sources of electric power and they are used to store the electrical energy. The primary cell or battery is a system whose useful life is ended once its reactants have been consumed by the discharge process. But the secondary battery is capable of being charged or recharged when its reactants have been used up. The spontaneous electrochemical reaction can be reversed by passing current through the cell in the opposite direction to that of cell discharge. It means the secondary battery might be considered as an electrochemical energy storage unit. For our application we select the lead acid battery because it came with less maintenance cost and more power efficient. Here we are using 24V dc motor so battery should supply 24V. We used two 12V battery in series connection to get 24V.

3.4 DC Motor

Almost every mechanical movement that we see around us is accomplished by an electric motor. Electric machines are a means of converting energy. Motors take electrical energy and produce mechanical energy. Motors are broadly classified into two types AC motors and DC motors. The AC motors operate on alternating current whereas the DC motors operate on the direct current. After doing the surveying on the DC motor we came to the conclusion that BLDC motor is the best for our application. The selection motor should be proper such that it should able to generate the enough torque to move the vehicle in forward path. That is the reason we select the BLDC motor of 250-350 W capacity for our project.

3.5 Chain Drive

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. There is very low friction, long as the chain is sufficiently lubricated. Continuous, clean, lubrication of the roller chain is the primary importance for the efficient operation as well as correct tensioning. Here chain drive is used for transmitting the motion from motor to the wheel via chain drive.

3.6 Ball Bearing

A bearing is a machine element which supports another moving machine element (known as journal). It permits a relative motion between the contact surfaces of the members, while carrying the load. Bearings are used to support large skyscrapers to allow them to move during earthquakes, and bearings enable the finest of watches to tick away happily. Without bearings, everything would grind to a halt, including people, whose joints are comprised of sliding contact bearings. There are two types of bearings, contact and noncontact. Contact-type bearings have mechanical contact between elements, and they include sliding, rolling, and flexural bearings. Mechanical contact means that stiffness normal to the direction of motion can be very high, but wear or fatigue can limit their life. Non-contact bearings include externally pressurized and hydrodynamic fluid-film (liquid, air, mixed phase) and magnetic bearings.

3.7 Mild Steel Rods

Steel is an alloys of iron with carbon being the primary alloying elements, up to 2.1% by weight. Carbon, other elements and inclusion within iron acts as hardening agents that prevent the movement of dislocations that naturally exist in the iron atom crystal lattices. Fig. 3.12 shows the schematic of Mild steel bars. Varying the amount of alloying elements, their form in the steel either as solute elements or precipitated phases, retards the movement of those dislocations that make iron so ductile and weak and so it controls qualities such as the hardness, ductility and tensile strength of the resulting steel. But only by trading away ductility of which iron has an excess.

4 DESIGN AND CALCUALTION

The following parameters are considered for the construction of solar cart

4.1 Torque Required

Gross weight of vehicle, (GVW) = 150kg

Radius of the wheel, (R_w) = 0.32m

Desired top speed, (v) = 10km/hr. = 2.78m/sec

Desired acceleration time, (t_a) = 20 sec

Maximum inclination angle, (α) = 10°

Worst working surface, = concrete

Co-efficient of static friction, (μ) = 0.55

Acceleration due to gravity, (g) = 9.81m/ sec²

Rolling resistance coefficient, (C_{rr}) = 0.004 (for bicycle tyres)

TTE= Total Tractive Effort

$$TTF = RR + GR + FA \quad \dots (1)$$

RR= Force Necessary to Overcome Rolling Resistance

GR= Force Required to Climb Grade

FA= Force Required to Accelerate to Final Velocity

f= fraction of total weight acting on driving wheel of vehicle

Rolling Resistance

The Rolling resistance can be calculated as:

$$RR = GVW \times C_{rr} \quad \dots (2)$$

$$= 150 \times 0.004 \times 9.81$$

$$= 5.886N$$

Grade Resistance

The grade resistance acting on the vehicle can be calculated as:

$$GR = GVW \times \sin \alpha \quad \dots (3)$$

$$= 150 \times 9.81 \times \sin 10$$

$$= 255.52N$$

Acceleration Force

Acceleration force is calculated as:

$$AF = \text{mass} \times \text{acceleration} \quad \dots (4)$$

We know that

$$v = u + at \quad \dots (5)$$

Where

v= Final velocity

u= initial velocity

a= acceleration due to gravity

$$2.78=0+ a \times 20$$

$$a= 0.139\text{m/s}^2$$

$$AF= 150 \times 0.139$$

$$= 20.85\text{N}$$

Total Torque Required To Drive the Wheel

The Total Tractive Effort can be calculated as:

$$TTE= RR+ GR+ FA$$

$$= 5.886+ 255.52+ 20.85$$

$$= 282.256\text{N}$$

The torque that is required on the drive wheel will be the one that the drive motor requires to produce so as to obtain the desired drive characteristics. The torque is:

$$\text{Torque } (\tau) = TTE \times R_w \quad \dots (6)$$

$$= 282.5 \times 0.32$$

$$= 90.32\text{N-m}$$

This torque can be obtained by directly mounting a motor with the torque value on the chain drive to magnify a lesser torque to this value before it drives the wheel.

Reality Check

The maximum torque is given as:

$$\tau_{\max} = (\mu \times GVW \times f \times R_w) / 2 \quad \dots (7)$$

$$= (0.55 \times 150 \times 9.81 \times 75 \times 0.32) / 2$$

$$= 9711.9\text{N-m}$$

$$\tau_{\max} \gg \tau$$

Hence no slip will occur.

$$\text{Angular velocity } (\omega) = \frac{v}{r} \quad \dots (8)$$

Where, r = radius of wheel = 0.32 m

Linear velocity of vehicle (v) = 10 km/hr = 2.78m/sec

$$\text{Therefore, } \omega = \frac{2.78}{0.32} = 8.687\text{rads/sec}$$

Now, frequency of motor, $f = \frac{\omega}{2\pi} = \frac{8.687}{2\pi} = 1.382 \text{ rpm}$.

Hence, the speed of the BLDC motor needed is 1.382 rpm.

Here the speed and frequency of motor is less because the desired speed of the cart is less.

Number of teeth on driving sprocket (n_1) = 9 teeth

Number of teeth on driven sprocket (n_2) = 42 teeth

$$\text{Gear ratio } (i) = n_2 / n_1 \quad \dots (9)$$

$$= 42 / 9$$

$$= 4:1$$

$$\text{Motor torque} \times \text{gear ratio} = \text{torque at wheel} \quad \dots (10)$$

$$\text{Motor torque} = 90.32 / 4$$

$$= 22.586\text{N-m}$$

$$\text{Power } (P) = \tau \times \omega \quad \dots (11)$$

$$= 22.58 \times 8.678$$

$$= 195.94\text{W}$$

$$= 0.26\text{hp}$$

Hence it is concluded that the motor with power of 195.94W is needed to drive the cart.

4.2 Solar Panel Capacity

The power required to charge the battery is given by the solar panel. Total power of solar panel required to drive the solar cart can be calculated as,

$$\text{Total power of solar panel} = [\text{battery voltage} \times \text{battery capacity} \times (1 + \text{loss}) \times (1 - \text{state of charge})] / \text{charge duration in hours} \quad \dots (12)$$

Assume,

State of charge = 0%

Losses = 25%

Charge duration in hours = 6 hours

Then, total power of solar panel = $[24 \times 17.76 \times (1 + 0.25) \times (1 - 0)] / 6 = 88.8 \text{ watts}$.

We get 90W as the standard size of solar panel so we keep the total value of as 90W.

5 CONCLUSION

The main motto of our project is to standardize the outlook of public toward the street vendors by providing a cart that contains facility like mobile charging lights motor driven and canopy. Traditional cart use human effort to move and doesn't have facility if lights, these cause vendors to depend upon the street light or other source of alternatives. Vendors are the medium between the farmers and consumer who cannot afford their products to sale in big market. We can reduce unemployment if we can target the mid-range people involve in this type business.

As the cost of cart is high but we can reduce the cost if we go for mass production and government provide the subsidy. Government can provide different identification system to manage the vendors and to manage the business.

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