



**EVOLUTION OF POSTAL SOLAR POWER RICKSHAW TECHNOLOGY
VIS-À-VIS
ECONOMIC FEASIBILITY**

Rajesh Kumar, Arun Agarwala

Instrument Design & Development Centre (IDDC), Indian Institute of Technology,
Delhi

Abstract

The evolution of machinery represents an expansion of human capacities, an increase in human control over environment through the ability to elicit from instruments of production an increasing range and exactitude of response. But it is in the nature of machinery, and a corollary of technical development, that the control over machine need no longer be vested in its immediate operator. This possibility is seized upon by the capitalist mode of production and utilised to the fullest extent.

The economic shaping of technology is, in fact, the social shaping of technology. The economic shaping, is one of Marx's- the realisation that economic calculation and economic 'laws' are specific to particular forms of society, not universal. Every city had different rickshaw design and one can find Kolkutta and Delhi rickshaws are totally changed, in considerations, design and aesthetic look. Even if in all societies people have to try to reckon the costs and benefits of particular design decisions and technical choices, the form taken by that reckoning is importantly variable.

A wider acceptance of scientific ideas in the society was a necessary condition for the achieving the major goals that the technology had set during inception of innovative idea. Phrases such as 'scientific temper' 'broad scientific outlook', scientific belief system' and 'scientific method' echoed repeatedly in various forms of debate on 'solar power rickshaw' design and evolution of different variant for innovative application.

Rural networking encompasses with postman that complete the societal networking. The country growth indicator reflected from the well connected society. The innovator vision is to empower postman with computer, internet, telephone, which support for post, email, talk, insurance, banking and safe secure parcel collection & delivery, up to last mileage of country. Solar power rickshaw fulfill the dreams of postman with reduced human drudgery employing complete green technology vehicle for the mobile post office.

The proposed solar power rickshaw development model have multiple organisational involvement, with Council of Scientific & Industrial Research (CSIR) as research and technology development, Department of Scientific & Industrial Research (DSIR) for promotion research and development (R&D) in private sector, Ministry of New &

Renewable Energy (MNRE) subsidy to sensitise postman for technology adoption and for covering trial risk of new renewable energy technology, Ministry of Environment & Forest (MoEF) for benefit sharing under PoA- CDM and Department of Post (DOP) for encouragement for rural mobile post office. The business plan on solar power rickshaw for mobile post office for postman has been workout in this study keeping in view that postman is best media for dissemination of information during his daily travel on an average 20 km.

Key Words : Solar Rickshaw, Postal Rickshaw, BLDC Motor, PMDC Motor

INTRODUCTION

In the busy streets of cities, mainly in Asian subcontinent, we find many tricycles and auto rickshaws. Auto rickshaws are driven by fossil fuel, which produces too much environment pollution. On the other hand tricycles or cycle rickshaws are used bear heavy drudgery to carry two no of passengers and suitable for narrow streets at a speed below 20 Km/hr. Introduction of Solar Powered Motor assisted pedicab has been thought to be a wise prerogative, mainly in the busy and narrow streets of cities and the rural area for traveling distance of 5-10 km daily. Central Mechanical Engineering Research Institute (CMERI) has developed Soleckshaw of which rear wheels are driven by manual power and front wheel is driven by Brush Less DC (BLDC) electric hub motor. The vehicle is powered by battery, which is charged at a solar power charging station during off time. This vehicle provides driving comfort with reduced drudgery to the driver due to addition of electric motor.

Technology determination theories explain the relationship between technology and

For correspondence:
rajesh38A@hotmail.com
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society, and it claims that change in technology is the most important cause of change in society. The theories on 'climatic determination' stress on the climate shape the nature of society. Technology may be seen as outside society only metaphorically. The technologists who produce new technology are in this view indeed members of society, but their activity is in an important sense independent of their membership of society. In the most common version of technological determinism, these technologists are seen as 'applying science', as working out the practical implications of new scientific discoveries, and those scientific discoveries are seen simply as new, more accurate insights into natural society. So Technology Determinism is consist of two parts, first, technology determinism is the technical change is in some sense 'autonomous' out society, literally or metaphorically. And the second part, that technical change cause social change [1]-[2].

Trends in the science-society relationship are often analysed via surveys designed to capture concepts such as the public's knowledge in science, attitudes towards science and scientists, levels of trust and confidence in science and science players, and interest in science and technology. Postman has presence

among the people and people strong belief on his credential is added advantage for the promotion of solar power rickshaw. A small real event to sensitise the role of postman in Indian culture and belief of the people on the post [3]-[5].

EVOLUTION OF TECHNOLOGY

The existing rickshaws design results from low scientific input and without considerations of design engineering on mechanical propulsion system, driver seat, wheel alignment, load sharing on front and rear wheel, pulling /pushing force and the drudgery bear by the rickshaw puller. The conventional poorly design impact on life style of a rickshaw puller and takes a heavy toll on the health of a rickshaw puller. The braking system is also very poor with only front brakes on the rickshaw. Thus when going downhill at high speeds sudden braking produces a catapult effect which results in overturning of the rickshaw. Similarly the seating arrangement is very uncomfortable and the aerodynamic drag of the system is very high. It is therefore humanly degrading to pull the existing inefficient cycle rickshaw. Yet because of poverty and no other source of income, migrant laborers do become rickshaw pullers and suffer adverse consequences to their health.

In India, presently the rickshaw manufacturing is an un-organised and low technology industry segment, without quality standard. The rickshaw design is available in different variants and these design changes with every city. Solar power rickshaw Era emanance after assessing need to improve the existing rickshaw to make it user friendly and bring quality control in its manufacture.

The rickshaw to Solar power rickshaw Era started in India in the start of 21st century and many scientist, technologist are

working on improved design of rickshaw. The major work is undertaken by different Indian Institute of Technology (IIT), engineering laboratory, engineering college and many NGO like NARI. The cycles maximus brand emerge as one of the world leader in innovation on rickshaw for different variant covering the different application. The modular designs are highly maneuverable, large and variant capacity, powerful braking on all wheel, extremely reliable heavy duty tyres, excellent rider visibility and safety of driver & passenger [6].

The Council of Scientific & Industrial Research (CSIR) designed pedicab has been named Soleckshaw; SOL stands for solar, E for Electric and CKSHAW for Rickshaw. It is a mobile post office on tricycle i.e. three wheeled vehicle driven by electric power, supplied by battery, which is charged from solar energy [7] [8]

GENESIS

The genesis from the desk of Professor Smir K. Brahmachari, Former Director General, CSIR, to improve lifestyle of pedicab (rickshaw) puller, by reducing drudgery, with technology intervention for improved design of the vehicle. Scientific Social Responsibility (SSR) is one such niche area of scientific behavior and governance that needs to get aggressively addressed and implemented tactfully in the organizations. At the same time SSR is one such effective tool that synergizes the efforts of technologist and the social sector agencies towards

sustainable growth and development of societal objectives at large. Indian community faces social challenges like poverty, population growth, corruption and illiteracy and hence its more imperative for the Indian scientific laboratory to be sensitized to SSR in the right perspective in order to facilitate and create an enabling environment for equitable partnership between the technology for civil society and business [9].

The assignment was given to country one of the excellent mechanical engineering research laboratory, Central Mechanical Engineering Research Institute (CMERI) and the prototype was designed in record time of less than 6 month by August, 2008. The goal was given to develop an optimally-designed, pedal-operated and motor assisted, zero-carbon emission, urban and rural transport vehicle. Soleckshaw is the flagship program of CSIR-800 initiative focused on improving the quality of life of 800 million Indians who are at the bottom of the quality of life pyramid [10][11].

The survey conducted by Indian Council of Medical Research (ICMR) on rickshaw puller to study tuberculosis (TB) disease, highlights shady picture of the spread of disease due to high drudgery and low intake calories. CSIR recognised that the rickshaws in use leave much to be desired in terms of efficiency, ergonomics and aesthetics. This is hardly amazing considering that the design has scarcely changed since it was introduced in India, without sharing the benefit scientific research. CMERI, Durgapur organized a workshop with participants from local city, plying rickshaw to fulfill their daily needs. Therefore actual rickshaw pullers

were invited to submit their wish list for a better rickshaw.

The following common points emerged:

- Provision for motorized assistance for haulage,
- Brakes on both front and rear wheel
- Larger tread width with better tyre
- Reduction of rickshaw deadweight
- Protective cover above the puller's head
- Energy efficiency through better designs of controllers

In order to obviate these detrimental factors, it is essential that India devises a policy and means to contain this through at first partial, and then total replacement of the offending vehicles with environmentally sound means of transport. The common 'rickshaw', which is found in large numbers in any part of the country, perhaps constitutes the ideal choice for providing this solution. Systematic introduction of 'rickshaws' or their various human powered variants (Pedicabs) is expected to have four major societal impacts as under:

1. Systematic Introduction of dual powered (human & solar) vehicles will help in conserving huge quantities of petroleum based fuels,
2. Being non-polluting, these will help in containing pollution,
3. Widespread dispersion of human powered vehicles will ensure large scale livelihood for the urban and rural poor, and
4. The measure will help elevating the dignity of human labour and generate employment for millions of Indian.

Solar Rickshaw TECHNOLOGY for Mobile post office

CSIR works on 'Soleckshaw' in the network mode with design node at CMERI, Durgapur in R&D coordination with CEERI on electronic controller, CECRI on battery, CEL on solar panel.

Mobile post office driven by pedal and assisted by motor operate on 36 V DC from battery bank, which is charged by solar photovoltaic cell. Rickshaw design provide traction assistance through specific designed brush less direct current (BLDC) motor, controlled by dedicated controller. The dedicated BLDC motor and controller has been designed for Solar



Fig 1- CSIR- Kinetic Engineering Mobile Post

power rickshaw and



Fig. 2- Mobile e-Post Office

still research work by CSIR labs and private companies is continuing for a better solution. Crompton Greaves Ltd has taken lead to provide solution for BLDC motor fitment on front wheel hub of Solar power rickshaw. The rear wheel have differential transmission for better control over the vehicle while turning and sloppy drive [12]-[13].

Technology on BLDC Motor

Solar power rickshaw is driven by a BLDC hub motor mounted at the center of front wheel directly replacing hub of wheel. The motor power is imparted in front wheel and manual drive on the rear wheel. Solar power rickshaw vehicle are three wheel driven, front wheel on BLDC and rear wheel by pedal driven powered with added override mechanism on rear axle to provide speed adjustment to rear wheels, whenever required.



Fig. 3-BLDC motor on front

Use of BLDC motor has eliminated torque enhancing devices and additional mounting structures. Finally use of motor power or the manual effort or the combination of both the drives, as and



Fig 4-Solar Rickshaw by IMML with BLDC motor

when required, constitute the non-obvious inventive steps[13] [14].



Fig.5-Solar Rickshaw design on PMDC by Dean System

Permanent Magnet Direct Current (PMDC) Motor on rear wheel

The initial work on motorised tricycle was concentrated around the design based on PMDC motor. During last decade of 20th Century many institutes like IIT, NARI, Dean system and many others had designed motorised tricycle start commercial sale. The maximum transfer efficiency measured for PMDC motor is 80%. Researcher are working on PMDC motor mounted on rear wheel for different model.

Explore Renewable Energy

The solar rickshaw is environment friendly using solar power for the motorized vehicle. The solar panel are used for charging of the specially designed battery for smooth power for running motor.

Besides being a major hazard to people's health, conventional transport vehicles are guzzling huge amounts of fossil fuels for which our country has to pay dearly in foreign exchange. In this scenario there is a need to encourage the use of electrically powered Cycle Rickshaws (Pedicabs). An electric cycle Rickshaws can provide a non-polluting and silent transport system for both urban and rural areas and busy cities. The low rolling resistance and light weight can make this vehicle very energy efficient and cost effective. The improved Pedicabs powered by electric motors and batteries have the potential to provide an attractive alternative. Besides, they can also provide extra income & comfort to the pedicabs operator. Solar Power is used to charge the batteries of these Pedicabs [15][16].

Two provision are made for charging of different models of rickshaw

- 1.Solar Charging Station – for charging of battery at the pre-installed solar panel station for charging more batteries at a time for a cluster of 'Solar Rickshaw'
- 2.Solar Panel mounted on vehicle – The panel mounted on the vehicle and its charge the battery using sunlight even while moving on road.

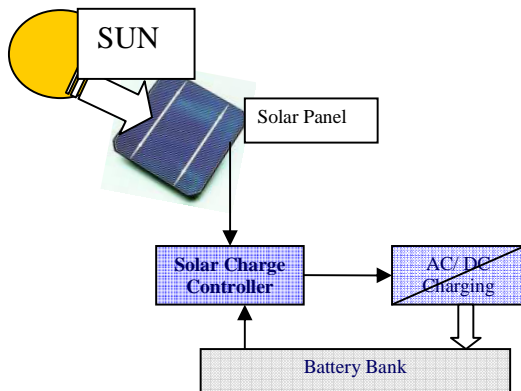


Fig. 6 - Solar Charging of Battery



Fig. 7- Solar Charging station

BUSINESS MODEL for MOBILE POST OFFICE ON 'Solar Rickshaw'

The economic calculations about technological innovation are open to challenge. They often seem primarily to be used to legitimate decisions already taken, rather than as the rational basis for decision. It is notorious that large technology projects, like nuclear power plant, almost always end up costing enormously more than initially estimate, in

part at least because an optimistic initial estimate helps gain support for the project.

Since *Solar power rickshaw* is essentially a pedal rickshaw with motor assist, the existing norms of pedal rickshaw commercialisation may impact on its marketing. The operator model is presently working in most of the city, an entrepreneur or business man owned more than 200 pedal cycle rickshaws. These owners either use their own resources for buying rickshaws or borrow money from local touts at high interest rates. The existing method has many disadvantages that the Solar power rickshaw business plan has tried to overcome or bypass. The Solar power rickshaw business model encourages the ownership transfer to the rickshaw puller. There is an operator, for a limited time, for ensuring Return of Investment.

Solar power rickshaw business model proposes to coordinate with different Government Departments for securing loans at lower interest rates, as these Departments, have programme for employment generation and social justice. Most of the nationalised banks have been given a mandate by the Government of India to give loans to rickshaw pullers so that they can own the rickshaw but the terms

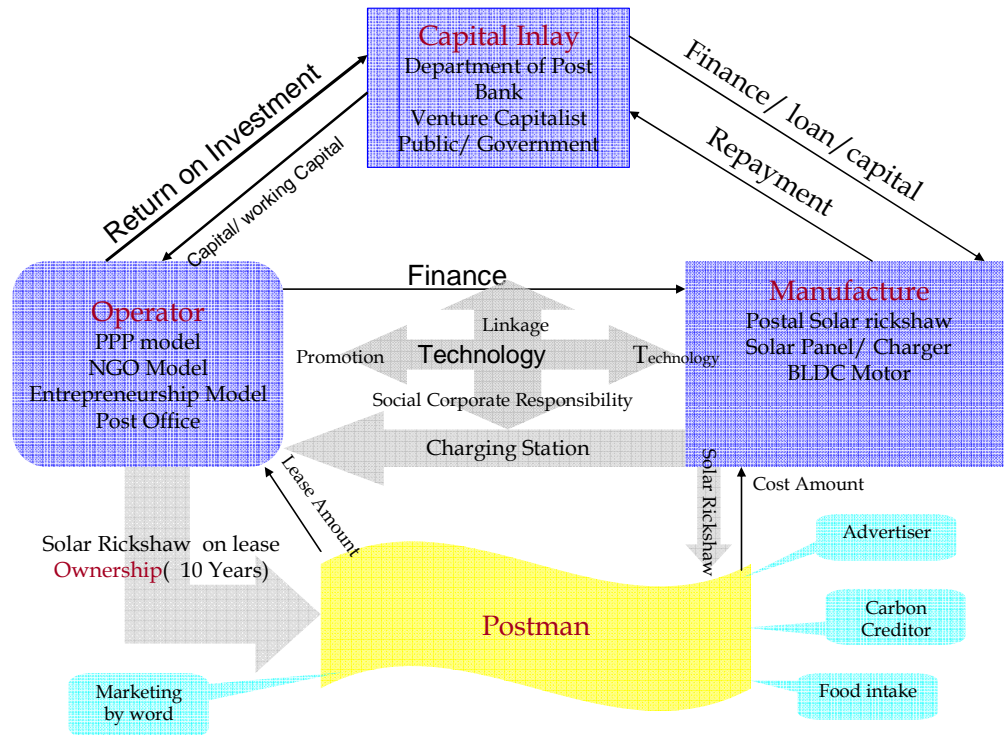
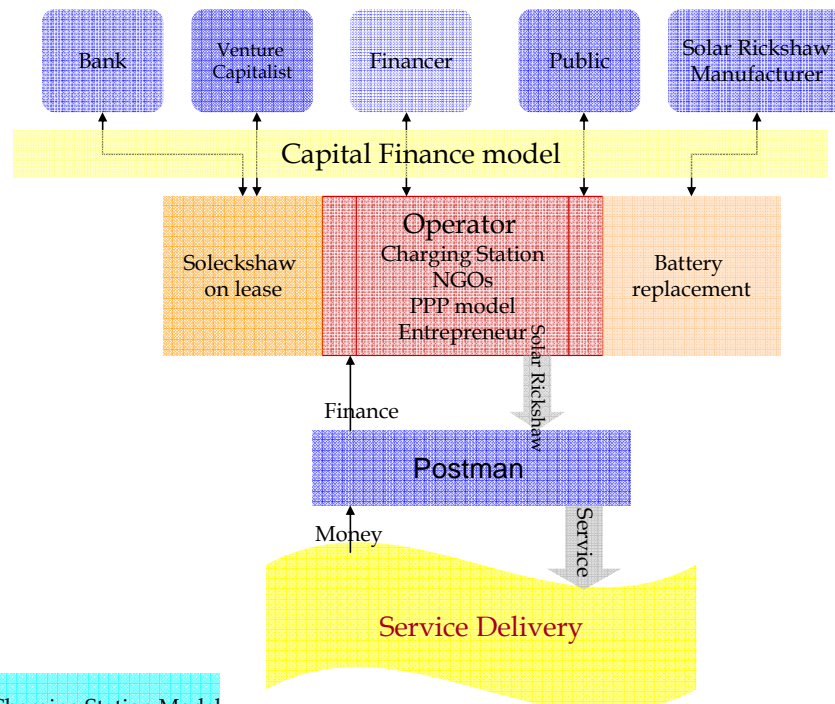


Fig. 8 Business model – Transfer of ownership with limited inclusion of operator and Government



Operation /Charging Station Model

Fig. 9 – Business model- without the role of Government

and conditions of these loans are tough. To make these facilities available to Solar power rickshaw puller, Small Industrial Development Bank of India (SIDBI) has innovative model which incorporates operator, preferably NGOs, with limited business interest. Fig. 8 explains the working of different components and their linkages, with inclusion of CSIR, Government and operator. Fig. 9 explains the role and responsibility of each model component, but without Government intervention as applicable in phase II. It is a sustainable model.

Return on Investment Plan (ROI) and Pay Back period

Monthly income for postman is designed with his income from the additional activities and recurring expenditure on services. The in-line with present assignment, the additional activities are plan for postal rickshaw postman as, Email, Net surfing, Phone call, Banking Services, Insurance, Courier, Utility bill, Advertisement on solar rickshaw, News paper distribution, Sale of forms (utility), Sale of stationery , Stamp Verification services, Instrumental to implement Govt. policy like UID, dissemination of government policies, NGO programme and public information.

Total Income per month = INR 9140
 (One USD \$= Approximately INR 60)
 Annual Income = INR 1,09,680

The cost of Solar power rickshaw commercial model is INR 70,000 with laptop and internet connectivity
Total expenditure, including depreciation = INR 46500 per annum

Total annual gain = 109680-42000
= INR 67680

Return on Investment on Solar power rickshaw in consideration of societal impact

$$\text{ROI} = \frac{(\text{Annual Gain} + \text{Depreciation}) \times 100}{\text{Capital Investment}}$$

$$= \frac{(67680 + 14000) \times 100}{70000} = 116.68\%$$

Pay Back period in Ownership Model for postman solar rickshaw

On return of saving & monthly installment INR 6806 per month comes out to INR 81672 in one year.

$$\text{Pay Back Period} = \frac{\text{Initial Investment}}{\text{Avg Cash flow}}$$

$$= \frac{70000}{(67680 + 14000)} = 10.28 \text{ months}$$

Where Avg Cash flow is Margin Per annum + cost of depreciation

Total duration to return Principal of INR 70000 in 10 months @ INR 6806 p.m.

Pay back period = 10 months.

Centralised Battery Charging Station Model (Sun hour charging)

Solar Charging Station for charging of battery at the pre- installed solar panel station for charging more batteries at a time for a cluster of 'solar rickshaw'

Total Income for charging station = 48000+14000= INR 62,000

Total cost of solar charging for 1200 batteries per month = 24x1200= INR 28800

Total Saving for the charging station = 62000-28800= INR 32,200 per month

Return on Investment for the Operator Battery Charger Model

$$\text{ROI} = \frac{(\text{Annual Gain} + \text{Depreciation}) \times 100}{\text{Capital Cost}}$$

$$= \frac{(32200 + 2241) \times 12 \times 100}{780000} = 52.9\%$$

Payback period

Cash available for pay back per month (Saving + Depreciation)

$$= 32200 + 2241$$

$$= \text{INR } 34441 \text{ [INR } 413292 \text{ p.a.]}$$

Pay Back Period

= Initial Investment / Avg. Cash flow.

$$= \frac{780000}{413292}$$

= 22.65 Months

Total Pay Back Period = 23 Months

OTHER PROMOTIONAL MECHANISM :

a) Subsidy on utilisation of Renewable Energy :

The subsidy part has been planned to sensitise rickshaw driver for technology up gradation and for covering trial risk of R&D and new technology absorption and adoption.

- The subsidy on the **interest part** to finance Solar panel charging system and Solar power rickshaw. It is proposed to provide finance with interest @ 1% for the purchase of *Solar power rickshaw* by the puller and solar panel & charger by operator. The subsidy may be considered for the compensation for matching amount of interest charge by banks @10% (apprx) and proposed finance to solar power rickshaw at 1%

- The 2nd part of subsidy is proposed for the compensation of cost @ 50% of the total cost of Solar power rickshaw,

Solar Penal & Charger to meet out expenditure on introduction of energy efficient technology development vis-à-vis conventional technology.

b) Benefit sharing on Programme of activities- Clean Development Mechanism (PoA-CDM)

The vehicle run on renewable energy and reduce drudgery to rickshaw puller is applicable for Certified Emission Reduction (CER) under UNFCCC programme PoA- CDM. Solar power rickshaw is propose for CER under following technology :

- Solar power used to run the vehicle in replacement of petrol.
- Human drudgery reduced saving on 2500 calories of food intake.
- Regenerative brakes, paddle and shockers for charging and storage of Battery.

POLICY ISSUES :

1. The policy need to identified the specific place, like chandni chowk and business like postman, where only solar power rickshaw vehicle is permitted.
2. For passenger carrying at University campuses and areas of tourist attraction like heritage sites, these environmentally sound and user friendly solar power rickshaw should be encouraged.
3. Since Solar power rickshaw is zero carbon green transport, environmentally sound and user friendly vehicle. The Technology should get all the financial benefits available to renewable energy projects along with all the Government of India schemes for providing employment to weaker sections of society.
4. The motor vehicle act : There is a need for concerned authorities in India to

exempt Solar power rickshaw from the purview of Motor Vehicle Act since it is essentially a pedal rickshaw with a small motor [4].

5. Ministry of Environment & Forest, National focal point for UNFCCC for consideration of human drudgery and food intake as carbon deposition in PoA-CDM project.

6. Solar power rickshaw may be promoted by private sector as Corporate Social Responsibility (CSR).

SUMMARY :

Solar power rickshaw vehicle is well designed for the daily traveling of 20 km and suits the business model of mobile post office and dispensary. The rural place has fuel crisis, which cost their hard income, is available at a distance more than they use the vehicle. This may increase the running of vehicle. This advantage from solar power rickshaw, fueled by sunlight, available in majority area made the sustainable model of business. The Solar power rickshaw can be use by the postman for his daily household and other small work. The vehicle will give new outlook to postman business and boost the penetration of post to larger width of society. Solar power rickshaw will certainly reduce the drudgery in cycling by postman with increase income with dignity. Some of the salient features of electric three wheeler for Indian postal department:

- Comfort, convenience to postmen: for mail delivery in urban and rural areas
- Totally green vehicle: No pollution of noise or no monoxides emission
- Comfort: Suspension in front and rear for greater comfort

- Flexibility: Dual operation i.e. battery power + man power in case of dire need
- Solar Charging: Batteries can be charged from solar power
- Economical: Very light in construction and economical to manufacture
- Ease of maintenance: Easy to maintain as bicycle parts are used
- Long range: In one charge, it can cover distance of 50 kms
- Applications: Can be customized for carrying many light materials like vegetables, eggs etc. and help many other sections of society

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