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Socio-economic & environmental impacts of battery driven auto rickshaw at Rajshahi city in Bangladesh

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ABSTRACT

This paper describes the socio-economic and environmental impacts of battery driven Auto Rickshaw at Rajshahi city in Bangladesh. Unemployment problem is one of the major problems in Bangladesh. The number of unemployed people in Bangladesh is 7 lacks. Auto Rickshaw reduces this unemployment problem near about 2%.In this thesis work various questions were asked to the Auto Rickshaw driver in the different point in the Rajshahi city. Then those data were calculated to know their socio economic condition. The average number of passenger per Auto Rickshaw was determined at various places of Rajshahi city (Talaimari mor, Hadir mor, Alupotti, Shaheb bazar zero point, Shodor Hospital mor, Fire brigade mor, CNB mor, Lakshipur mor, Bondo gate, Bornali, Panir tank, Rail gate, Rail Station, Bhodrar mor, Adorsha School mor).

Air pollution is a great threat for human health. One of the major causes of the air pollution is the emission from various vehicles, which are running by the burning of the fossil fuel in different internal combustion(IC) engines. All the data's about emission from various power plants were collected from internet. Then the amounts of emission (CO_2, NO_X and PM) from different power plant were calculated in terms of kg/km. The energy required by the Auto Rickshaw per km was also calculated. Then the histogram of emission from different vehicles in terms of kg/km was drawn. By analyzing the data and chart, it was found that, battery driven Auto Rickshaw increases income, social status, comfort and decreases unemployment problems.

Keywords: Auto rickshaw, socio-economic, renewable energy, Sound pollution, Air pollution.

1. Introduction

An electric car is an automobile that is propelled by one electric motor or more, using electrical energy stored in batteries or another energy storage device. Electric motors give electric cars instant torque, creating strong and smooth acceleration. Electric cars were popular in the late 19th century and early 20th century, until advances in internal combustion engine technology. Electric cars have several benefits compared to conventional internal combustion engine automobiles, including a significant reduction of local air pollution, as they have no tailpipe, and therefore do not emit harmful tailpipe pollutants from the onboard source of power at the point of operation. [1]

2. Region and nick name

These electrically charged vehicles run all over the world. Mostly it is used by South Asian regions. The name of electric charged type vehicles are varied from place to place.

- ✓ *Bangladesh : Auto*
- ✓ *Nigeria : Keke-marwa*
- ✓ *Egypt : TukTuk*
- ✓ *Eastern Africa : Boda-bodas*
- ✓ *Indonesia : Bentor*
- ✓ *Cambodia : Tuk-Tuk*

3. Battery and charging system

The charging type Auto Rickshaw collects its power from electricity supply line.

It collects charge by two ways:

(1) By grouping system

(2) By individual system

In grouping system it needs Tk.130 to Tk.150 for full charge per Auto Rickshaw. And in individual system it needs Tk.90 to Tk.110 for full charge per Auto Rickshaw.

The time required for complete charging of battery used in electric vehicle is between 8 to 12 hours and always charged between 10pm to 8am. The total number of battery in battery driven Auto Rickshaw is 4 to 6 pieces. But most Auto Rickshaws has 5 pieces. And it is kept below the seat.

4. Positive impacts of battery driven Auto Rickshaw

4.1 Cost

Table 1: Comparison of fare among various vehicles

Vehicles	Auto	CNG	Rickshaw	Mishuk
Cost per (1-3)km	Tk.7	Tk.7	Tk.15-20	Tk.7

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4.2 Human comfort

By the observation it is known that most people like Auto Rickshaw due to

- Less Travelling cost
- Pollution free
- Availability

Table 2: Percentage of passenger preference for various vehicles

Vehicles	Auto	CNG	Rickshaw	Mishuk
% of the passengers	50	35	2-5	10-13

4.3 Power plant

The load on power stations varies from time to time due to uncertain demands of the consumers and is known as variable load on the station.

Effects of variable load:

a) Need of additional equipment
b) Increase in production cost

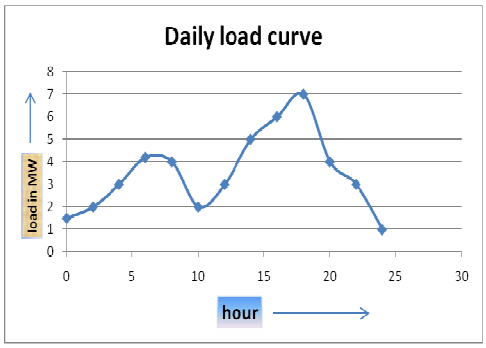

Fig1 Daily load curve

In power supply system the whole day is divided into two hours (peak hour & off peak hour). During peak hour the load is very high (generally 8am to 10pm). So the power supplier has to supply more power. But during off peak hour (generally 10pm to 8am) the variation of load is very low compared to peak hour. So power plants needs to supply more power during peak hour than the off peak hour. For supplying more power it requires more additional units which run during peak hour. But it is stopped during off peak hour. To start a power generating unit (say Gas turbine) it takes few hours & huge wastes of energy.

4.4 Air Pollution

Air pollution from Auto Rickshaw is negligible. It can be easily seen from the comparison with the other vehicles.

Table 3: Comparison of air pollution among various vehicles

Vehicles	Auto	CNG	Rickshaw	Mishuk
Pollutants from exhaust gas	N/A	NOX, PM	Nill	NO_X, SO_X, CO_2.CO etc.

4.5 Sound pollution

Table 4: Comparison of sound pollution among various vehicles

Vehicles	Auto	CNG	Rickshaw	Mishuk
Sound	Low	Medium	Negligible	High

4.6 Solution of unemployment

The total number of Auto Rickshaw at Rajshahi city is 5,000 legally [Rajshahi city corporation] and 2,000 illegally. By the observation on 436 numbers of Auto driver, 56 number of Auto driver was unemployed. So, 8% of the unemployed people get job at Rajshai city in Bangladesh.

5. Drawbacks

5.1 Traffic jam

The number of Auto Rickshaw is increased day by day. It creates traffic jam in a narrow road or point of road. Auto Rickshaws are being parked in the busy road as well as foot path and traffic jams are the consequence of the mismanagement. The tolerable number of Auto Rickshaw at Rajshahi city is 5,000 [Rajshahi city corporation]. But the present number of Auto Rickshaw at Rajshahi city is near about 7000. This excessive number of battery driven Auto Rickshaws are increasing traffic jam.

5.2 Road condition

It is not suitable for hilly road or bad weather due to its low power capacity.

5.3 Air pollution

Generally it doesn't create any air pollution during running. But lead (Pb) is emitted from waste battery and that pollutes water, soil and air. The amount of energy consumed by the battery driven Auto Rickshaw come from various power plant. The power plant always pollutes the air. So, battery driven Auto Rickshaw indirectly pollutes the air.

5.4 High Purchasing cost

The purchasing cost of battery driven Auto Rickshaw is so high. The minimum price is near about Tk. 2, 00,000 which is seven times to Rickshaw. So, a Rickshaw puller has not capacity to buy it. As a result, the Rickshaw pullers become unemployed. For their family maintaining, they have to do illegal job and even commit a crime.

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5.5 High maintenance cost

The average maintenance cost of battery driver Auto Rickshaw per month Tk.800-Tk.1000, which is very high as compared to Rickshaw and similar vehicle.

5.6 High replacement cost

The periodic cost of battery driver Auto Rickshaw is near aboutTk.70, 000 per 18 months. This periodic cost is the cost of rechargeable battery replacement and the cost of DC motor.

5.7 Load shedding

Developing country like Bangladesh power crisis is one of the major problems. Battery driven Auto Rickshaw is not harmful for power plant. But it is increasing load shedding problem in Bangladesh. Because still now, Power plant can't full fill our demand both in peck and off peck hour.

6. Top most air polluted city in Bangladesh

Dhaka is back again on the number one position. Air pollution in capital city Dhaka has gone higher than Mexico City and Mumbai killing thousands prematurely each year. According to the Department of Environment (DOE), the density of airborne particulate matter (PM) reaches 463 micrograms per cubic meter (MCM) in the city during December-March period - the highest level in the world. Mexico City and Mumbai follow Dhaka with 383 and 360mcm respectively. The air quality in Dhaka city improved by 25 per cent after the withdrawal of the two-stroke vehicles from it road. [2]

7. Comparison among CO_2 emission of battery driven Auto Rickshaw, SI & CI engine vehicle

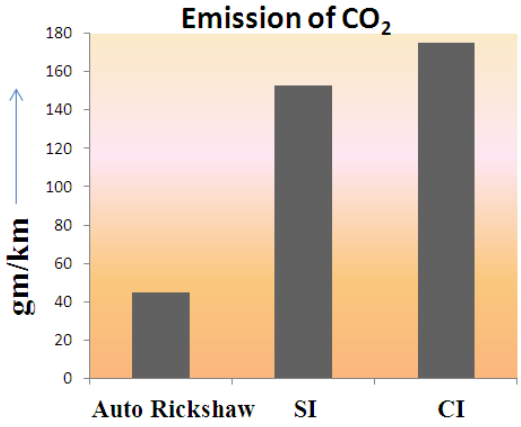

Fig. 2 CO_2 emission of battery driven Auto Rickshaw, SI & CI engine vehicle

The amount of energy consumed by the battery driven Auto Rickshaw is near about 10 kWh per charging. It can travel at an average distance of 150 km per charging. The transmission lost is 16% of the energy consumed. So total amount of energy consumed per km is 0.067 kWh. The power plants have to produce 500 gm CO_2 per 1 kWh. So to produce 0.067 kWh the amount of CO_2 emission from the power plant is near about 45.24gm.The actual emissions in g/km on petrol and Diesel car are 153.57 and 175.94 respectively. [3]

8. Over view of power consumption

Total numbers of Auto Rickshaws at Rajshahi city in Bangladesh are 7,000. [Rajshahi City Corporation]
Rated power consumption:
Total voltage = 12×5= 60 volt.
Total power consumed = 5× (12×140) = 8.4 kWh
= 8.4 units
By direct observation the actual power consumption is 10 kWh. The transmission loss is 16% of actual power consumption =10×16%=1.6 kWh

So, total power supplied by the power plant =11.6 kWh
A single Auto Rickshaw needs minimum energy 11.6 kWh per day. In Rajshahi city total numbers of Auto Rickshaws are 7,000. So Auto Rickshaw consumes energy 81.2 MWh per day i.e. 10.15 MW. And the average load at Rajshahi city in Bangladesh is 235 MW. The average load due to battery driven Auto Rickshaw at Rajshahi city in Bangladesh is 10.1 MW, which 4.32% of the total load at Rajshahi city in Bangladesh. [4]

Table 5: comparisons between incomes

Life of Auto (month)	Previous income (Tk.)	Present income (Tk.)
4	600	700
24	300	550
7	500	600
36	350	600
19	400	500
36	1000	700
4	300	650
3	250	400
6	330	300
9	250	400
8	330	700
16	400	650
36	350	600
30	350	700
12	400	600
8	350	650
6	200	700
30	250	600

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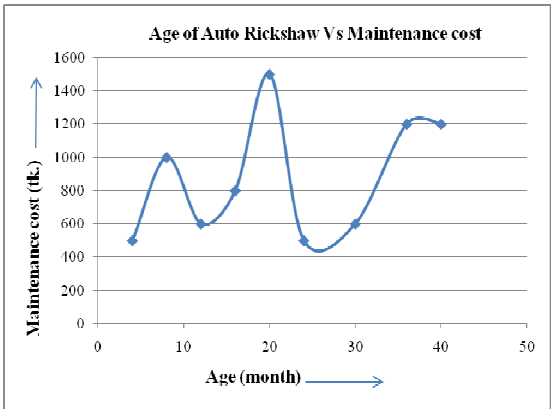
The above table shows the economical impacts of battery driven auto rickshaw at Rajshahi city in Bangladesh. The previous income of the battery driven auto rickshaw driver is nearly half of their present income.

Table 6: Various cost of Auto

Age (month)	Monthly maintenance cost(Tk.)	Replacement cost(Tk.)
4	400	0
24	1500	1,32,000
7	1000	0
36	1200	65,000
19	1500	72,000
36	1000	2,20,000
4	500	0
3	500	0
6	500	0
9	350	0
8	200	62,000
16	800	0
36	1200	1,30,000
30	500	1,30,000
12	600	0
8	200	0
6	1000	70,000
30	600	1,30,000
24	500	1,30,000
5	600	0

The adverse economical impacts are the maintenance cost and the periodic replacement cost of motor and batteries. This periodic replacement cost is near about Tk.85,000.



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The above figure shows the variation of maintenance cost with respect to age of Auto Rickshaw. The average maintenance cost of Auto Rickshaw is Tk.1,000 in every 3 to 6 month. The main cause for maintenance cost is to replace carbon. Carbon is replaced in every month by Auto driver. The replacement cost is gradually high with increasing the age of Auto Rickshaw. Maintenance costs also include tire repairing, circuit repairing, brake show changing etc.

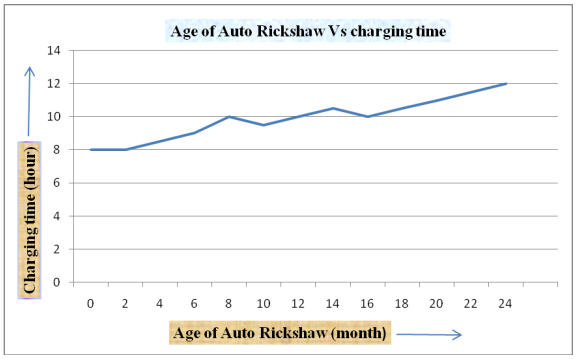

Fig.4 Performance curve-1of battery driven Auto Rickshaw

The above graph shows the age of Auto Rickshaw VS charging time characteristics. The charging time is increasing almost with increase of age of Auto Rickshaw indicating that, day by day the performance is decreased as well as time required for full charging is increased. At the beginning period the time required to full charge the batteries is near about 8 hours. But day by day as the batteries grew older, the time required for charging the battery fully is above 8 hours. At the end it takes 12 hours or more. Finally after 24 to 28 months the batteries have to replace by new battery, which is very costly. The approximate value is Tk.70,000 for five pieces. This is one of most important disadvantage of battery driven Auto Rickshaw.

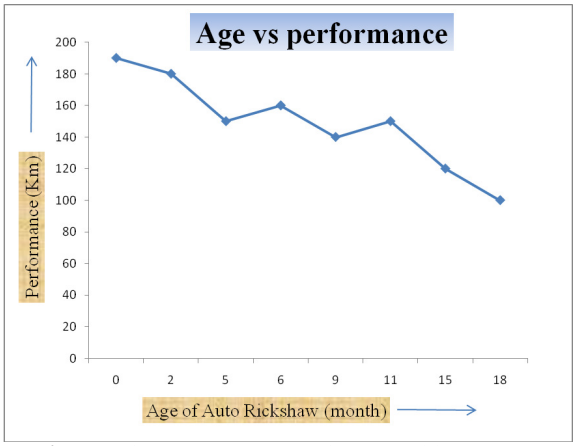

Fig.5 Performance curve-2 of battery driven Auto Rickshaw

The above graph shows the performance of the Auto Rickshaw battery with respect to Age of Auto Rickshaw.

It shows that, the performance of the battery getting poor with Age of Auto Rickshaw. At the beginning the Auto Rickshaw can travel more than 160 km per full charge. But when it grows older the Auto Rickshaw travels less than 160 km, even less than 100 km. After 24 months the battery performance becomes so poor that it must be replaced by new battery. But the price of each battery is very high. It is near about Tk.14000.The average number of battery per Auto Rickshaw is five. So the total replacement cost of battery is near about Tk.70,000. The maintenance cost is near about Tk.1,000 per month. The total income in 24 months is near about 550×30×24=Tk.3, 96,000. The daily expense of Auto driver is near about Tk.300. In 24 months 300×24×30=Tk.216000. So, the savings in 24 months is 396000-216000=Tk.180000.Saving after purchasing battery is 1, 80,000-(70000+24,000) =Tk.86,000

Table 7: Change in life style of auto driver

Point of view	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)
Social status	31.8	0	13	23	32.2
Relaxation time	45.4	5	10	10	29.6
Comfortable job	63.6	0	10	5	21.4
Economic condition	27.3	15	22.7	15	20
Daily saving	77.3	10	12.7	0	0

The above table shows the social impacts of battery driven auto rickshaw at Rajshahi city in Bangladesh. More than 30% of auto drivers think that, this occupation increase their social status and more than 50% are strongly disagree. More than 50% of auto drivers agree with the increase in their relaxation time and 27% disagree. More than 87% of auto drivers agree with the increase in their daily saving and nearly 40% agree with prosper in economic condition. Most of the auto drivers think that, it is a comfortable job than their previous jobs.

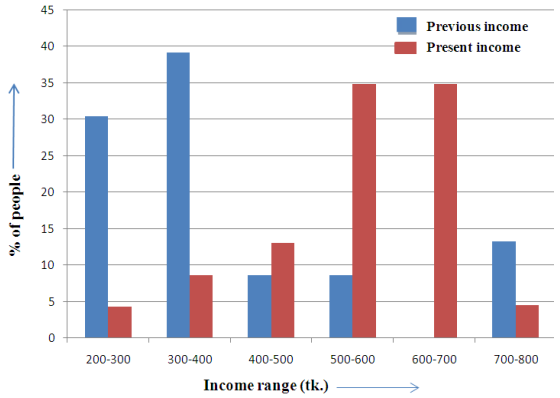

Fig.6 Comparison between previous income and present income of auto driver

The above histogram shows the various income range of the battery driver Auto rickshaw driver. Red line represents the present income and blue line represents the previous income range. From the above histogram it is clear that 70% of the Auto driver's previous income range was Tk.200-400. But at present 68% of the Auto driver income range is Tk500-700 tk. So,Auto Rickshaws increase the income range by 75%.

9. Discussion

All data's were collected from battery driven Auto Rickshaw driver. Some data which were far away from the majority data were neglected. In Bangladesh it is very difficult to identify actual number of Auto Rickshaw. So, it was very difficult for us to work with this topic (especially from Bangladesh point of view). The average value of power consumed by the battery driven Auto Rickshaw were taken for calculating total energy consumption per day at Rajshahi city in Bangladesh. Rajshahi city was taken as a model for this thesis. Some data were collected from internet. There was insufficient data about Rajshahi. So, the ideal data of energy, pollution were taken from internet.

3. Conclusions

Battery driven Auto Rickshaw is preferable than Rickshaw and other similar IC engine vehicles.

- ✓ It does not have any adverse effect on pollution from Bangladesh point of view.
- ✓ It can reduce environmental pollution.
- ✓ Its sound level is within the tolerable limit.
- ✓ It is a respectful occupation than Rickshaw driver.
- ✓ It runs with smooth vibration.
- ✓ It reduces unemployment problem.
- ✓ Old & lame person can drive it.
- ✓ The battery does not valid more than two years.
- ✓ Due to high price, a Rickshaw puller cannot buy Auto Rickshaw.
- ✓ It can be easily used as a solar car.

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- ✓ It can be used as an alternative of CNG in Dhaka city.
- ✓ Increase load shedding problem at Rajshahi city in Bangladesh.
- ✓ Purchasing cost of battery is very high.
- ✓ Maintenance cost is also very high.

4. Recommendation

- ✓ The rechargeable battery should be modified.
- ✓ The rechargeable battery should perform for a long time.
- ✓ It can be used as a solar car by using solar panel at the top roof of car.
- ✓ A wind turbine can be used in front of the Auto Rickshaw.
- ✓ Weight should be lighter.

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