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Techno-economic Analysis for a Sustainable Mobile Charging Device

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Abstract— Since a vast segment of population presently using bicycles and having huge penetration of mobile phones, it is an opportunity to harness these two phenomenon for sustainable progress. In this research, a sustainable mobile charging device was developed. Furthermore, an economic analysis was conducted to project its viability in monetary terms. In this regard, SWOT analysis, PEST analysis, break-even point, etc. were carried out. The analysis shows a significant saving and therefore implies a good prospect for commercial production by the relevant industry and government alike.

Keywords— Mobile Charger, Renewable Energy, Techno-economic Analysis, Environmental Impact, Energy Saving, Product Design, Sustainability

INTRODUCTION

As the environmental consciousness is growing, many people now a day are using bicycle. Besides the majority of the people now have mobile phones. To charge the mobile phone, usually electricity from the national grid is used. So a significant volume of electricity is used for this purposed. Again due to proliferation mobile, household members may not able to charge their mobiles altogether at a given time. Therefore if the mobile could be charged while travelling bicycles would save money on the electricity usage while make it convenient for the users. In this research, scope of development of such device was explored technically and economically. Then a rigorousdesign of the product was done and later fabricated with indigenous materials. The usage of this mobile charger was reviewed by a sample of the users.

Many people are all over the world are now use bicycles as a mode of short distance travel. Again, now almost every adult has a mobile phone. They need to charge their phones. The people are now conscious enough about saving energy even in the rural areas. The use of power bank cannot save energy rather it consumes energy. Whereas, a paddle operated battery charger uses the rotational energy to charge the phones without consuming energy. At present, people look forward to buy new and convenient gadgets. This would definitely be an excellent optionfor them. We also did SWOT analysis, PEST analysis of the idea. Saving energy is the main concern of our project. So we also showed how much energy we can save by using this product.

Techno-economic modeling is that well-established process, which when developed in concert with technology, ensures that market-driven prices can be achieved [1, 2, 3]. Typically, this is part of the “stage-gate” process in the corporate management of product development and related research. As the foreground, and with its components embedded in a selected designs system model, techno-economicmodeling becomes an invaluable, direction-steering tool [4,5,6].

TECHNICAL CONSTRUCTION OF THE MOBILE CHARGER

The mobile charger device takes higher alternating current (AC). Then it converts it to direct current(DC) for recharging a cell phone or other mobile device.A bike generator was used which is technically considered to be an Alternator. The circuit uses a rectifier, capacitor and a voltage regulator.The rectifier converts the back and forth lifting waves of AC to steady stream of DC. The large capacitor helps to smooth up the voltage level.The voltage regulator holds the incoming DC power creating the voltage around 5 volts.This voltage is accepted and repeated for mobile phone.In short, when engaged, the generator wheel rolls against the bike tire. The motion produces electricity, and the greater the biker’s pedaling speed, the greater the voltage output. The circuit board’s bridge rectifier, which converts the AC to DC is connected by a cord from the generator. Therefore, the up-and-down, positive-to-negative

current becomes a steady positive current. After that, the capacitor levels out the DC voltage and produces a steady voltage inflow to the voltage regulator. Fast pedaling can produce 30 volts or more, but the cell phone only needs five volts to charge. So the voltage regulator must be in place to protect the charger from literally burning out. The regulator controls the voltage keeping the voltage entering the cell phone within the threshold value. The circuit diagram is provided in Figure 1.

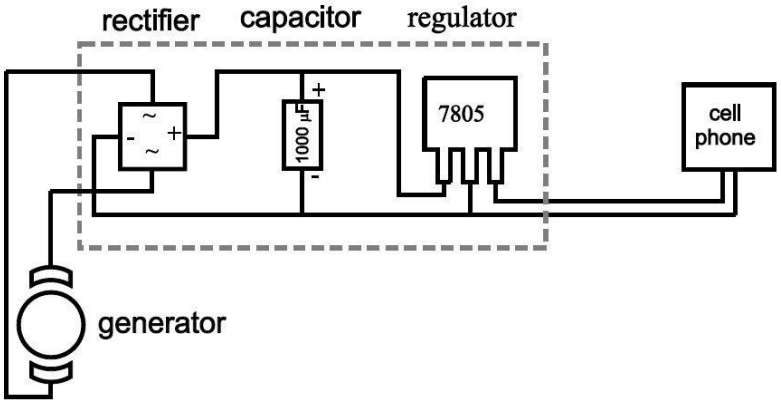

Figure 1 Basic Circuit Diagram of Paddle Operated Mobile Charger[7]

Materials and Tools used in the fabrication were as follows

- Adapter socket cable
- Bicycle Headlight Generator ,12V 6W
- Grommets ¼ inch
- Small bicycle saddle bag
- Micro USB Adapter
- Grip clip
- 1000 µF 35V Electrolytic Capacitor
- Silicon Bridge Rectifier (400 V ,1.5 A)
- +5 V fixed voltage regulator 7805
- Cable ties
- Insulated ring tongue lugs
- Screws, bolts, washers , nut
- Hook up wire
- Wire tool
- Soldering iron and solder
- Screw drivers
- Drill and bits

Figure 2: Paddle Operated Mobile Charger Assembled in a Bi-cycle

ECONOMIC ANALYSIS

In order to get a full overview of the economic aspect of the sustainable mobile charger, the following analyses were carried out. SWOT analysis stands for Strength, Weakness, Opportunity and Threat. It is a simple but powerful tool to analyze get the holistic view. In this research, SWOT analysis was conducted to get the situation analysis for the innovative mobile charger which is described in Table 1.

SWOT Analysis

SWOT analysis stands for Strength, Weakens, Opportunity and Threat. It is a simple but powerful tool to analyze get the holistic view [8, 9]. In this research, SWOT analysis was conducted to get the situation analysis for the innovative mobile charger which is described in Table 1.

Table 1 : SWOT Analysis

Strengths	**Weaknesses**
• It costs less than power bank & other competitors • Itis safe to use & no loss of electrical energy • It gives Greener environment & saves energy • Easy to carry & sustainable solution to the bikers	• Tyre wear • Require more force to drive the paddle
Opportunities	**Threats**
• In the city region the number of bikers are increasing, so it opens a new market. • In rural areas electricity isn't available all the time. So they can use it as an alternative source of power.	• Local power bank producer who can sell the product in cheaper price. • Solar panel based mobile charger.

PEST Analysis

PEST analysis stands for Political, Economical, Social and Technological analysis. It is a widely used tool to cover some of the aspects of situation analysis that are often overlooked [10, 11]. In this research, PEST analysis was conducted to get the situation analysis for the innovative mobile charger which is described in Table 2.

Table 2: PEST analysis

Political Analysis	• The department of renewable energy published several articles to encourage people for using renewable energy sources. • RAJUK is also encouraging building in the urban areas to use renewable source of energy. • Government is planning to give subsidiaries in producing and importing renewable energy products. • Government is patronizing local business giant like Rahimafrooz to produce renewable energy products.
Economical Analysis	• Its a low price alternative of power bank to charge the smart-phone. • It saves electric energy which reduces cost associated with our electricity. • It takes less money to buy our product.
SocialAnalysis	• People are using more bi-cylces now-a-days to avoid traffic as well as to save energy. People are getting more concerned about the environmental issue. • Paddle operated mobile charger would help them to have more flexibility in using bi-cycle & encourage them to use environment friendly solutions.
Technological Analysis	• Paddle operated mobile charger uses a simple technology in a bi-cycle for a modern purpose with a mission to save energy & sustainable future.

Cost Analysis

During fabrication, we collected the components from local markets. After collecting the components we contacted with the whole-sellers and got an approximate pricing of each components.For mass production we suggested that selective whole-seller or manufacturers should be used to maintain the same quality product and same price.In Table 3 and Table 4 cost of all such items are provided.

Table 3: List of components with approximate price

No.	Components	Cost , TK. (Approximate)
01.	Generator (12V, 6W)	310
02.	Saddle Bag	50
03.	Silicon Bridge Rectifier (400V,1.5A) & +5V Fixed Voltage Regulator	25
04.	Wire (2types- 2 gauge & 0.5 gauge)	20
05.	1000-micro F 35V Electric Capacitor	20
06.	Micro USB	15
07.	Grip Clip	15
08.	Grommets, lungs, Screws, Bolts, Washers	15
09.	Total	470

After going through the cost of componets, we suggest to 1200 units per month. We set this by considering the current market demand and market size.In labor we suggest wages as 157 TK per unit. And 4 devices can be produced per hour on an average.

Fixed Cost**:**A cost that does not change with an increase or decrease in the amount of goods or services produced. Fixed costs are expenses that have to be paid by a company, independent of any business activity. Factory overhead cost, facility rent etc are the examples of fixed cost.

Variable Cost: A corporate expense that varies with production output. Variable costs are those costs that vary depending on a company's production volume; they rise as production increases and fall as production decreases.Variable costs can include direct material costs or direct labor costs necessary to complete a certain project.

Table 4 : List of all costs

Cost Name	Total Cost Per Month, Tk.	Cost Per Unit, Tk.
Material Cost	564,000	470
Labor Cost	18,000	15
Fixed Cost (Facility Rent & Tools)	30,000	25
Marketing Cost	18,000	15
Transportation Cost	12,000	10
Total	642,000	535

- We suggest to sell this product at 750Tk. per unit to the retailer and 900Tk. per unit directly to the customers.
- This would give us a minimum profit margin of 215Tk. per unit.

Benefit-Cost Ratio Analysis

Benefit cost ratio provides indication of whether the business would be viable for the owners and for the customers as a whole[12].

Benefit-Cost Ratio = Profit Per unit (215) / Cost Per Unit (535) = 0.40

- The ratio is below 1 which gives negative point for this product. But considering the current market competition and growing demand, this business can be a profitable one.
- For selling this product directly to the consumers, we can avail a profit of 365 Tk. Per product. That will give us a higher benefit-cost ratio.

Benefit-Cost Ratio = Profit Per Unit (365) /Cost Per Unit (535)= 0.69

- So we suggest for initial stage the target market should be the retailers as they are the one to easily reach the customers. By increasing marketing of the product we might expand the market share and increase profit by directly supplying to the customers.

Break-even Analysis

Break even quantity suggests how many of the items to be produced in a given time period to reach breakeven [12,13].

$Sp \times Q = Ve \times Q + Fe$

Here,Sp = Selling Price of unit product

Q = Quantity to be produced

Ve = Variable expenses per unit

Fe = Fixed Expenses

Now, 750*Q = 510*Q + 30,000

Or, (750-510)*Q = 30,000

Or, Q = 125

Therefore, 125 products to be produced to meet the break-even point.

Monetary Savings

- The major selling of this product would be energy saving. So how much actually we are saving by using the Paddle Operated Mobile Charger would be the energy savings.
- A normal charger gives output of 0.7A & 5V which will charge a 2200mAH battery in

  2.2 AH / 0.7 A = 3.14 Hours

- A normal charger takes input of 240V, 0.15A. So power consumed by the charger

  240*0.15 = 36W

- If per KW/Unit current cost on an average of 7 Tk.
- Annual Cost Saved = 0.036*3.14*30*12*7 = 285 Tk.
- So, if one person uses paddle operated mobile charger instead of conventional mobile charger, he might be able to save **285**tk. annually.
- If we consider Six thousand people are using Paddle Operated Mobile Charger after seven month of marketing. We might be able to save 17,10,000 Tk. worth electricity annually. The amount will be increasing with time.

CONCLUSION

Techno-economic analysis was carried out on an innovative sustainable storage medium to find out its commercial viability. From the analysis, it is evident that the mobile charger could be produced economically. Besides, it is shown that it could save the users with electricity cost. Therefore it may be concluded that this innovative sustainable paddle operated mobile charger would be an efficient device for the economic development in line with safe guarding environment.

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