

Economic Feasibility Study of Hard rock Extraction Using Quarry Mining Method at Companiganj Upazila in Sylhet District, Bangladesh

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Abstract Companiganj is one of the resourceful upazila of Sylhet district, though no gas or oil field have not been found yet, renowned for its hard rock. Hard rock, one of the main geo-resources of Bangladesh after gas and coal, is very useful in construction sector and cement industry. The source of this rock is near Meghalaya of India. This part of India is relatively in higher than the ground level of Bangladesh. That's why the rock comes down by gravity especially in the rainy season. The water is the main transportation media which brings these rocks. People normally use manual hand tools for rock extraction and use two type of crusher to crush these rocks. In this research paper, we tried to find the economic feasibility of extracting these rocks. Though the extraction method of this quarry is not technologically advanced, but after doing this research, we can say that this quarry is economically feasible.

Keywords: *companiganj, Sylhet, Geo-resources, hard rock, crusher, economic feasibility*

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1. Introduction

The feasibility Study is an exercise that involves documenting each of the potential solutions to a particular business problem or opportunity. Feasibility studies aim to objectively and rationally uncover the strengths and weaknesses of the existing business or proposed venture, opportunities and threats as presented by the environment, the resources required to carry through, and ultimately the prospects for success [1]. In this paper we will discuss about the economic feasibility of hard rock quarry at Companiganj Upazilla in Sylhet District. The purpose of the economic feasibility assessment is to determine the positive economic benefits to the quarry mining. This assessment typically involves a cost benefits analysis.

1.1. Geology and Geography of Companiganj

Geologically, this region is complex having diverse geomorphology; high topography of Plio-Miocene age such as Khasi and Jaintia hills and small hillocks along the border. At the centre there is a vast low laying flood plain, locally called Haors. Available limestone deposits in different parts of the region suggest that the whole area was under the ocean in the Oligo-Miocene [2].

Companiganj is located at 25°04'45"N 91°45'15"E-25.0791°N 91.7542°E. It has 13620 units of house hold

and total area 278.55 km² is bounded by Meghalaya (state of India) on the north, Sylhet sadar on the south, Gowainghat upazila on the east, Chatak upazila on the west. Main rivers are Surma, Piyain. Notable Haors: Baors, Pokohair. Notable Beels: Panichapara, Nagar, Rauti and Kalenga [3].

1.2. Some Features of Companiganj Upazila

Companiganj (Town) consists only of one mouza. It has an area of 9.21 km². It has a population of 6365; male 54.12%, female 45.88%; density of population is 691 per km². Literacy rate among the town people is 15.2%.

Administration: A police outpost was established at Companiganj in 1976 which was upgraded to an upazila in 1983. The upazila consists of three union parishads, 74 mousas and 131 villages.

Religious institutions: Mosque 130, temple 4, tomb 3.

Population: 85169; male 51.86%, female 48.14%; Muslim 91.16%, Hindu 8.73% and ethnic people 0.1% (Monipuri).

Literacy and educational institutions: Average literacy 43.05%; male 50.6%, female 35.5%. Educational Institutions: College 1, Secondary School 7, Junior High School 3, Primary School (Government) 32, Primary School (Non-government) 27, Community School 10, Satellite School 6, Madrasa 11. Vatrai High School (1957), Parua Noagaon Dakhil Madrasa (1965) are notable educational institutions.

Cultural organisations: Rural club 14, playground 5, Women's organization 12.

Main occupations: Agriculture 45.87%, Agricultural Laborer 16.54%, wage laborer 9.58%, Fishing 4.32%, Commerce 7.01%, Service 1.72%, others 14.96%.

Land use: Arable land 29676.40 hectares, Khas land 999.84 hectares.

Land control: Among the peasants 51% are landless, 16% marginal, 25% intermediate and 8% rich.

Value of land: Market value of the first grade agricultural land is about Tk. 2500 per 0.01 hectare.

Main crops: Paddy, mustard, cassia leaf, betel leaf and betel nut.

Extinct and nearly extinct crops: Tobacco, ganja (hemp) is entirely extinct.

Main fruits: Orange, jackfruit, mango, lemon, pineapple, satkora.

Fisheries, dairies, poultry: Fishery 15, dairy 20, poultry 35.

Communication facilities: Roads: pucca 41.15 km and mud road 160 km.

Traditional transport: palanquin and bullock cart. These means of transport are extinct or nearly extinct.

Cottage Industries: Weaving 20, Goldsmith 40, Blacksmith 30, Potteries 80, Welding 3.

Hats, bazaars and fairs: Hats and bazaars are 14, fair 3; Companiganj Bazaar, Islamganj Bazaar, Tukur Bazaar, Parua Bazaar are notable.

Main Exports: Orange, fish, stone (boulder and pebble), limestone.

NGO Activities: CARE, BRAC, Grameen Bank and Simantik.

Health Centre: Upazila health complex 1, satellite clinic 1, family planning center 3 [4].

1.3. Basic information of Rocks in Companiganj

Hard rock a term used loosely for igneous and metamorphic rock, as distinguished from sedimentary rock. Hardrocks in Bangladesh are of four types. (i) Maddhyapara subsurface hard rock (ii) Bholaganj-Jaflong hard rock concretions (Companiganj) (iii) Tetulia-Patgram-Panchagar hard rock concretions and (iv) Chittagong hilly track sedimentary concretions. The terms (ii), (iii) and (iv) are usually considered as gravel deposits. The Bholaganj (under Companiganj Upazilla) hard rock project is approximately 850 km². The hard rock is mined following the open pit technique. The worker extracts hard rock by using their hand operating tools. In so far as the Dupitila formation, this immediately overlies the hard rocks in the region. The hard rocks are to be extracted from a depth of 2.5 meter to 10meter below the surface [5].

The Sona Tila gravel bed is equivalent to the lower Pleistocene series and belongs to the Madhupur clay formation while the Bholaganj gravel bed is equivalent to the upper Pleistocene to Holocene series. Similarly, the former is weathered and the latter is fresh, hard and high quality derived from the Khasi-Jaintia hill ranges. The gravels of both beds are of igneous and metamorphic origins. They have high sphericity and roundness values and as such suggest long transportation and long time abrasion of the gravel sediment. They are made of river borne deposit [6].

1.4. Quarry Mining

A quarry mine is a type of open-pit mine from which rock or minerals are extracted. Quarries are generally used for extracting building materials, such as dimension stone, construction aggregate, riprap, sand, and gravel. They are often collocated with concrete and asphalt plants due to the requirement for large amounts of aggregate in those materials. The word quarry can include underground quarrying for stone, such as Bath stone.

Quarries in level areas with shallow groundwater or which are located close to surface water often have engineering problems with drainage. Generally the water is removed by pumping while the quarry is operational, but for high inflows more complex approaches may be required. For example, the Coquina quarry is excavated to more than 60 ft (18 meter) below sea level. To reduce surface leakage, a moat lined with clay was constructed around the entire quarry. Ground water entering the pit is pumped up into the moat. As a quarry becomes deeper water inflows generally increase and it also becomes more expensive to lift the water higher during removal - this can become the limiting factor in quarry depth. Some water-filled quarries are worked from beneath the water, by dredging [6].

1.5. Crusher

A crusher is a machine designed to reduce large rocks into smaller rocks, gravel, or rock dust. Crushers may be used to reduce the size, or change the form, of waste materials so they can be more easily disposed of or recycled, or to reduce the size of a solid mix of raw materials (as in rock ore), so that pieces of different composition can be differentiated. Crushing is the process of transferring a force amplified by mechanical advantage through a material made of molecules that bond together more strongly, and resist deformation more, than those in the material being crushed do. Crushing devices hold material between two parallel or tangent solid surfaces, and apply sufficient force to bring the surfaces together to generate enough energy within the material being crushed so that its molecules separate from (fracturing), or change alignment in relation to (deformation), each other. The earliest crushers were hand- held stones, where the weight of the stone provided a boost to muscle power, used against a stone anvil. Querns and mortars are types of these crushing devices [7].

There are two types of crushers (small and large) are found in Bholaganj area. Small size crusher are named "Tom tom" by local people.

2. Materials and Methods

In order to conduct this study, steps like field investigation, data collection, analysis, economic consideration are done. Field investigation includes site visiting, conversation with Upazila Nirbahi Officer, visiting different quarry, visiting different type of crusher and data collection from small and large crusher. Data collected based on survey and questionnaire by visiting the location several time.

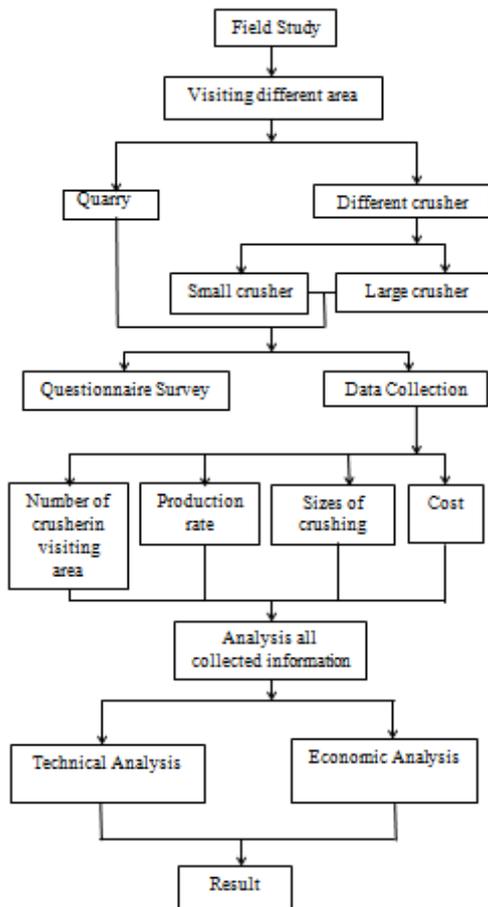


Figure 1. Flow chart of methodology

3. Data Collection

Data mainly collected from three locations- Companigonj Bajar, Volagonj and Konabari.

Companiganj Bajar: There were 40 small crushers and 75 large crushers in the Companiganj area. We observed most of the area and collect data from 2 small crushers and 2 large crushers.

Bholaganj: There were 80 small crushers and 110 large crushers in the Bholaganj area. We observed and collected data from 3 small crushers and 2 large crushers.

Kolabari: There were 40 small crushers and 60 large crushers in the Kolabari area. We observed and collected data from 2 small crushers and 2 large crushers.

There are approximately 350 large size crushers in the project area. Data are collected from six large crushers at different place of the project area. They are P&S Stone Crusher, Borak Stone Crusher, Akash Stone Crusher, S.M Stone Crusher and Surma Trading and Kashem Stone Crusher.

There were approximately 160 small crushers in the project area. Data was collected from local businessmen or owner of small crusher. Few data were collected from the workers. There were some business firm from which we collected data and they are Gazi Trading, Bangla Trading, S.Alam Trading, Zia Trading and Protik Stone Crushing.

Local businessmen gather hard rock by using day laborer or worker. Then they crush different size rock and sell them to local customer. The local customers collect

crushing rock and send them to different part of the country.

Table 1. Collected data from the location

Data Collecting Point	Total Number of Crusher		Number of visited crusher	
	No. of small crusher	No. of large crusher	small crusher	large crusher
Companiganj	40	75	3	2
Bholaganj	80	110	3	2
Kolabari	40	60	2	2

Production of Small Size Crusher:

The production of a small size crusher is 700-800 ft³/day. The number of total small size crushers is 160, so according to this the total production by small size crushers are 45000 ft³/day and the annual production of crushed rock is 1.65 x 10⁷ ft³.

Production of Large Size Crusher:

The production of a large size crusher is 2500-3000 ft³/day. The total number of large size crushers is 350, so according to this the total production by large size crusher is 962500 ft³/day.

Selling price of crushed rock using small crusher:

Hard rock is crushed into different required size. Their prices are also varying with their size and also with the size of crusher. The most required size is 3/4. The size 3/4(boulder) are most costly than others. The cost of 3/4 (boulder) is 0.84-0.85 USD/ft³ and the cost of 3/4 (bhuto) is 0.70-0.72 USD/ft³. The size 1/2 and 5/10 are residual and their price are less than 3/4 sizes. The cost of 1/2 size is 0.57-0.58 USD/ft³. The price of 5/10 size are 0.28-0.30 USD/ft³ which are less costly than other size. The prices are also varying with cost of raw material.

Selling price of crushed rock using large crusher:

The cost of 3/4 (boulder) is 0.86-0.90 USD/ft³ and the cost of 3/4 (bhuto) is 0.73-0.80 USD/ft³. The size 1/2 and 5/10 are residual and their prices are less than 3/4 size. The cost of 1/2 size is 61-0.64 USD/ft³. The price of 5/10 size is 0.28-0.30 USD/ft³ which is less costly than other size.

Investment cost of crusher:

Investment cost is the cost to set up the machinery or corresponding material during the early life of an industry. 20616 USD is required to set up the small size crusher and 47674.5 USD is required to set up the large size crusher. All the crushers are imported from the China.

Table 2. Total Production of crusher

Crusher type	Total Production	
	Per day (ft ³)	Per year (ft ³)
Small crusher	45,000	1.64x10 ⁷
Large crusher	9,62,500	3.51x10 ⁸

Table 3. Labor cost per crusher

Crusher	Labor consumption/crusher	Labor cost per day/crusher (USD)
Small crusher	8	30.92
Large crusher	22	85.04

Table 4. Selling price of crushed rock from small crusher

Crushed type	Size of crushed rock	Selling price (USD)
Small size crusher	3/4 (Bhuto)	0.70-0.72
	3/4 (Boulder)	0.84-0.85
	1/2	0.57-0.58
	5/10	0.28-0.30

Table 5. Selling price of crushed rock from large crusher

Crushed type	Size of crushed rock	Selling price (USD)
Large size crusher	3/4 (Bhuto)	0.73-0.80
	3/4(Boulder)	0.86-0.90
	1/2	0.61-0.64
	5/10	0.28-0.30

Table 6. Cost of raw material of a crusher

Crushed type	Amount of rock bought by a crusher/ft ³	Total cost of raw material* (USD)
Small crusher	1325	256.09
Large crusher	3975	768.27

* cost of raw material 0.19 USD/ft³

Table 7. Cost scenario per crusher

Crusher type	Investment cost per crusher		Total income per crusher per year(USD)
	Set up cost (USD)	Operating cost* (USD)/day	
Small crusher	20616	38.66	21260.25
Large crusher	59271	118.54	59271

* Operating cost includes labor cost and fuel consumption by a crusher

Table 8. Total profit from crusher

Crusher type	Profit per year (USD)
Small crusher	7086.75
Large crusher	15977.4

* Profit = Total income - operating cost

4. Result

For Small crusher

$$\begin{aligned} \text{Return on investment [\%]} &= (\text{Income}-\text{Cost}) / \text{Total cost} \\ [7] &= (7086.75/14173.5) \times 100 \\ &= 50\% \text{ per year} \end{aligned}$$

For Large crusher

$$\begin{aligned} \text{Return on investment [\%]} &= (\text{Income}-\text{Cost}) / \text{Total cost} \\ [7] &= (15977.4/43293.6) \times 100 \\ &= 36.9\% \text{ per year} \end{aligned}$$

5. Discussion

From the above calculation we can see that a small crusher is beneficiary with respect to a large crusher. But net income in a large crusher is more than twice of a small crusher.

It can be noticeable that when raw materials are crushed into different size and shape then their selling price increase because it's public demands is much more than it's original size and shape which is found in quarry and consequently in this regard the efficiency of investment (return on investment) increased.

So, from this study we can say that –

This rock extraction project is economically profitable. And the benefits from selling the rock worth the cost.

6. Conclusion

Hard rock is known as the building material which usually used in construction. Bholaganj is one of the main sources of hard rock and are used in construction all over the Bangladesh. But no appropriate engineering technology is used here to extract this hard rock. Local people are extracting this hard rock by using hand operating tools. At least 9,000 people including 3000 women and 1000 children is working as stone laborer, on the bank of the Dholai River, in Bholaganj, Companianj, Sylhet. The average income of the stone laborers is less than 150 taka per day. Stone extraction goes on in the area for about eight months a year, except the rainy season. On an average 300 truck load of stones are sent to Sylhet and other parts of Bangladesh every day. Based on this, local people get involve in rock business and crushing business. Maximum labors in crusher mills and workers who working in quarry for extraction purposes are local people of Sylhet district. Not only local people but also people of other districts involve here. An unemployed people can get involve here easily. So it is clearly visible that a great working place has been created here. These rocks of Companiganj are assets of local area of Bangladesh. Future study is required to extract these economically valuable rocks by environment friendly way using the modern mining technology.

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