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STATUS OF THE BRICK INDUSTRIES IN BANGLADESH: A CASE STUDY FROM THE RAOZAN SUBDISTRICT OF CHITTAGONG DISTRICT

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ABSTRACT : *This study was conducted at the Raozan subdistrict of the Chittagong district to explore the status and activities of the brick industry. The survey was conducted during the period from March to April 2017 by a semi-structured questionnaire. A total of 14 Fixed Chimney Kilns and four Zigzag Kilns were selected randomly in Raozan subdistrict. The production period of brick industries was October to April in each fiscal year. Annual production of bricks from each industry was about 5 million. Workers in the brick industries were mainly migrant people, of which 98.5% were male and 60.7% were skilled and semi-skilled. The main constituent of bricks is clay, 50% of which was collected from agricultural land, 22% from uncultivated upland, and 28% from both agricultural and uncultivated uplands. Fuelwood and coal were the major types of raw materials consumed by brick kilns to produce energy for burning bricks. Respondents living closer to the brick industry agreed more with the modernization of brick industry than those living farther away. Similarly, respondents living closer than 500 m from brick industries stated that the brick industry could not provide employment opportunity to local people more than those living farther away from brick kilns*

KEYWORDS: *brick, kiln, distance, attitude, Bangladesh.*

I. INTRODUCTION

Bricks are becoming a significant building element in both urban and rural areas of Bangladesh. The demand for bricks in Bangladesh has increased by about 5.3% per year [(1)], but the total households of Bangladesh amount to 31.7 million people, of whom 26.1% use bricks as construction material [(2)]. To meet a growing demand, brick industries are mushrooming across the country, with a high density on the outskirts of cities. The estimates of kilns vary with different sources, from 4,140 [(3)] to 5,000 [(4)]. According to official records of the Department of the Environment (DoE), Bangladesh has about 6,335 brick industries in production.

Brick manufacturing enterprises are not recognised as industries in Bangladesh for two main reasons: firstly, their seasonal activities do not provide year-round employment. Secondly, most of the brick kilns are on rented land, and there is no fixed property except the chimney. According to ESMAP[(5)], the total brick production in Bangladesh is estimated at over one billion bricks annually, with an estimated sales value of about US $1.2 billion, or about 1% of Bangladesh's GDP.

In Bangladesh, people universally prefer brick as a wall, roof and floor material. At the village and rural enterprise level, bricks are produced with the production technology, which varies with the manufacturer's size and scale [(6)]. Furthermore, the brick industry generates a lot of employment, especially during the off-farm season. The emphasis in this study, however, is to explore the current state of the brick industry and activities towards the brick cluster in Chittagong district. In this case, this study was undertaken in Raozan subdistrict of Chittagong district between March and April 2017 to achieve the following specific research objectives: (i) to understand the current state and activities of the brick industry; and (ii) to explore the local people's perception of the technical development and contribution of the brick industry in creating employment opportunities in their area.

II. MATERIALS AND METHODS

2.1 Study area

According to the information provided by the Department of Environment (DoE), there were about 1,269 brick industries in Chittagong Division in 2017. Chittagong district harbours about 321 brick manufacturing units, which is one of the largest clusters of brick industries within the Chittagong Division. Brick industries of Raozan were selected for the final field survey, considering the communication facilities from the University of Chittagong. Raozan subdistrict is located at 22.53°N latitude and 91.93°E longitude (Fig. 1). Brick industries of Raozan subdistrict were mainly located in Dabua and Raozan Sadar unions. Prior to final field survey, the questionnaire was revised and finalised based on challenges or limitations as identified from the reconnaissance survey.

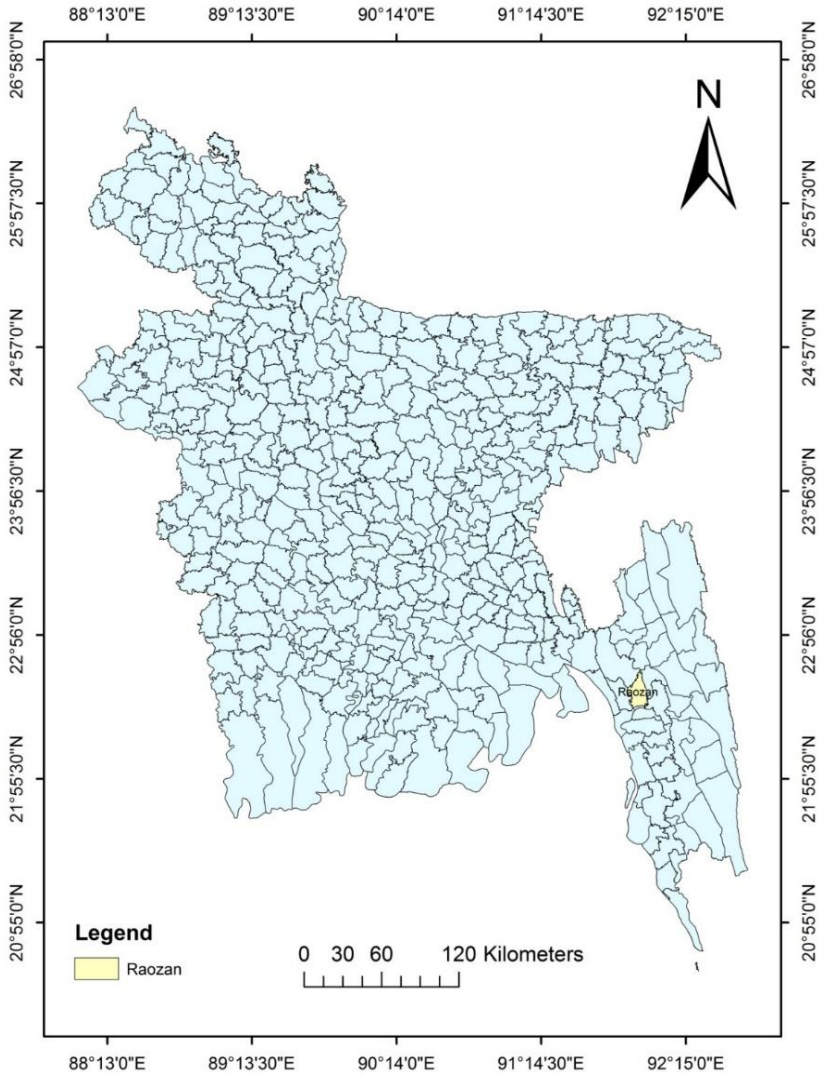

Figure 1: Location of Raozan subdistrict (yellow mark) in Bangladesh map

2.2 Collection of data and data analysis

Before going to the field, several attempts were made to collect secondary data from the Department of Environment (DoE), Chittagong district. Secondary information included names of brick industries located in Raozan subdistrict, with contact details of owners. Fieldwork at various brick industries was conducted from March to April 2017. Before going to the field, a total of 39 owners of brick industries located in Raozan subdistrict were contacted by telephone to arrange an appointment for data collection. Out of 39 owners, 31

showed enormous interest in assisting this study. Thereafter, 18 out of 31 industries were selected randomly for surveying by using semi-structured questionnaires. The questionnaires included the following information: name of the brick industry, year of establishment, and production of the bricks each year; production cost and price of 1,000 bricks; selling quantity and profit in last year; types, sources, quantity, and transportation cost of raw materials, used for the production of energy for burning green bricks; establishment cost of brick kiln and constraints of kiln technology used in the industry; number of workers with the ratio of male and female, nature of workers skill (i.e., efficient or inefficient), working hours, and their wages based on the nature of work each season; procedure of brick manufacture; source, quantity, collection time, collection procedure and collection cost of raw materials (i.e., clay and sand) for the manufacturing of green bricks; types of wastes generated from the brick industry with waste disposal systems; and barriers related to technical, financial investment, and institutional rules and regulations etc. A literature review was also conducted to collect secondary information about the nature of brick industries in Bangladesh from different scientific journals, proceedings, websites and newspapers.

Fieldwork was conducted from March to April 2017. In order to explore the perception of local people regarding the role and development of brick industries in their locality, a total of 72 respondents were interviewed randomly by using a semi-structured questionnaire at different distances from the brick industries. The questionnaire included information related to socio-economic and demographic features, for example, respondent's sex (i.e., male and female), age, occupation (i.e., agriculture, business, housewife, and student), education (i.e., illiterate, ≤ primary, secondary, higher secondary, and above higher secondary), household size, monthly family income, distance of their households from the brick industry, and a couple of statements related to the attitude of respondents towards the technical development and the contribution of brick industries to generate employment opportunity in their locality, such as, brick industry provides employment opportunity to us (i.e., agreed, don't know, disagreed), and brick industry should be modernised technologically (i.e., agreed, don't know, disagreed). Usually household heads, mostly males, were interviewed, but in their absence, any member, mostly housewives, willing to participate were interviewed. Open-ended questions were asked at the end of the structured portion to collect as much information as possible.

2.3 Data analyses

Data were analyzed using SPSS version 16.0 (SPSS, Chicago, USA). The differences between variables were explored using χ^2 (Chi-squared) tests of independence and one-way ANOVA (analysis of variance). Stepwise linear regression analysis was performed to analyse relationships between multiple variables.

III. RESULTS

3.1. Area and production status of brick industries in Raozan subdistrict

The operational period of brick industries in Raozan subdistrict is from October to April in each year. Out of 18 brick industries, about 78% industries were built on Fixed Chimney Kiln, while remaining industries used Zigzag Kiln technology. The construction cost of Fixed Chimney Kiln (i.e., BDT 1.7 m) was cheaper than Zigzag Kiln (i.e., BDT 2.7 m). The cost mainly depends on the construction of structure and chimney type. The height of a Zigzag Kiln ranged from 16.8 m (55 ft.) to 18.3 m (60 ft.), while Fixed Chimney Kilns ranged from 36.6 m (120 ft.) to 39.6 m (130 ft.).

Altogether 23.7 ha of land were used by 18 brick industries with a mean of 1.3 ha/industry, which comprised 0.1% of the total land area (i.e., 4,751 ha) of the Raozan subdistrict. The area of the brick field varied considerably among industries ($F = 202.5$, $df = 17$, $p = 0.05$) ranging from 0.6 to 3.2 ha. The total annual production of bricks for 18 industries was 79.8 million, with a mean of 4.4 million each year for each industry, which accounted 0.5% of the total annual production of bricks of the country (i.e., 17 billion). The annual production of bricks/ industry ranged from 1.6 million to 6.0 million and the mean annual production for each industry also varied substantially between the types of brick kiln ($F = 14.9$, $df = 1$, $p = 0.001$). The mean annual brick production of Fixed Chimney Kiln (4.8 ± 0.7 million) was higher than the production of Zigzag Kiln (3.1 ± 1.1 million).

3.2 Workforce and labour wage in brick industries

The workers in brick industries are mainly migrant people from north-western parts of the country. A total of 2,298 workers, with a mean of 128 workers per industry, were employed in brick industries in the production season, of which 98.5% males and 1.5% females, while 60.7% skilled and semi-skilled. The skilled and semi-skilled workers are particularly employed for making and drying green bricks in addition to operate brick kiln.

On an average, most workers perform hard physical labour for more than 10 hours per day. However, each worker can produce more than 1,200 green bricks per day with a total production of 22,200 bricks by 18 industries. The workers can be categorised into different groups such as earth cutting, brick making and drying, firing and burning of green bricks, and loading with unloading of bricks into kiln. The owners of 18 brick industries reported that they usually recruited workers in a group upon an agreement made between the owner of the industry and the leader of each group for each production season. Thus, the payment mode of labour wage for each group was on a seasonal based. Among workers, 55% were involved in brick making and drying, with 28% in loading and unloading of bricks into brick kiln, 12% in earth cutting, and 5% in firing and burning green bricks. Labour wages of 18 brick industries was BDT 212 million in each year, of which 40% accounted for making green brick and drying, and 60% for earth cutting and firing together with loading and unloading of bricks into brick kiln.

3.3 Consumption of raw materials for energy production in brick kilns

Fuelwood and coal were the major types of raw materials consumed by brick kilns to produce energy for burning green bricks. Both fuelwood and coal were used in the Fixed Chimney Kiln, while for Zigzag Kiln, only coal was used. Total annual consumption of fuelwood and coal by 18 brick kilns were 27,055 t and 9, 030 t, respectively. The average price of coal/ ton (BDT 9,819.4 ±1390.8) was more than twice the price of fuelwood (BDT 4,802.9 ±689.4) as reported by the owners of brick industries. Total transportation cost of raw materials from different sources for 18 industries was BDT 23.6 million/year. Altogether, the overall collection cost of both fuelwood and coal for 18 industries was BDT 243.2 million/year. The owners of brick industries mentioned that they collected fuelwood from Raozan, Hathazari, Fatikchari, Kaptai, and Rangamati regions, and coal from Tamabil of Sylhet district, as well as from Chittagong port.

3.4 Raw materials for the production of green bricks used in brick industries

Three different materials viz. clay, sand, and water are essential for producing green bricks. Clay is collected throughout the year except during the rainy season. The amount of clay (11775.1 ±2070.2 m^3) required by each industry was more than 20 times higher than the amount of sand (578.1 ±114.9 m^3) required each year, as reported by the owners of brick industries. The requirement of sand and water for 18 industries were 10,406 m^3 and 417,000 m^3, respectively. The average price of clay and sand was BDT 274 ±55.6 / m^3 and BDT 538.1 ±114.9 / m^3, respectively.

3.5 Profit/loss and problems in brick industries

The total investment, total income, and net profit/loss each year in production and marketing of bricks for 18 brick industries were BDT 572.5 million, BDT 625.1 million, and BDT 52.6 million, respectively. The mean annual investment for production was slightly lower in Fixed Chimney Kiln (m BDT 31.7 ± 4.4) compared to Zigzag kiln (m BDT 32.1 ± 9.0). On the other hand, the mean annual income from the marketing of bricks was a little higher in Fixed Chimney (m BDT 35.3 ± 4.7) than Zigzag kiln (m BDT 32.7 ± 8.4). Thus, the average net annual profit was higher in Fixed Chimney Kiln based industries (m BDT 3.6) than Zigzag Kiln based industries (m BDT 0.6), but among the perceived problems associated with development of brick industries, three kinds were recorded. The problems were: (i) lack of loan with low interest from bank to adopt energy efficient technology, (ii) lack of training facilities in energy-efficient technology to minimise the cost of production and (iii) lack of high-quality coal in the local market at reasonable price. Nearly about 40% owners of brick industries mentioned that they were unable to adopt energy-efficient technology due to lack of loan with low interest. However, more than 22% owners of brick industries expressed that, due to lack of training facilities on energy-efficient technology, they failed to maximise the profit in brick production. Nearly about 38% owners of brick industries also expressed that the unavailability of high-quality coal at reasonable price in local market hindered the production of bricks to the desired quantity.

3.6 Attitudes of local people towards brick industries

3.6.1 Brick industry should be technologically modernized

About two-thirds of respondents agreed that the brick industry should be technologically modernised, which varied significantly with the distances from brick industries (Table 1). Respondents who lived closer than 500 m from the brick industry agreed more with the statement 'Brick industry should be technologically modernised' than those respondents living farther away. A stepwise linear regression analysis with variations in attitudes of respondents towards whether brick industry should be technologically modernised as the dependent variable was tested with eight independent variables (Table 2); only two of them proved to be significant contributors to the variation. The variables, which significantly explained variations in this statement, were distance the

respondents lived from the brick industry and medical expenses of households. The other independent variables were insignificant. All the independent variables explained 15.3% of the variation of people's opinion related to this statement. Those living closer to the brick industry agreed more with the statement than those living farther away. Similarly, those who paid higher costs for medical treatment agreed more with the statement (Table 2).

Table 1: Respondent's (%) opinion towards brick industry located at various distances from the brick industry in Raozan subdistrict

Variable	Opinion	Distance from the boundary of brick industry to human settlement (m)					Statistics		
		<100	101-500	501-1000	1001-2000	Total (n=72)	*χ^2	df	p
Brick industry should be modernized in technologically	Disagree	11.1	5.6	27.8	66.7	27.8	33.8	6	0.0001
	Don't know	0.0	0.0	0.0	16.7	4.2			
	Agree	88.9	94.4	72.2	16.2	68.1			
Brick industry provides employment opportunity to us	Disagree	66.7	16.7	16.7	27.8	31.9	16.1	6	0.013
	Don't know	0.0	16.7	5.6	11.1	8.3			
	Agree	33.3	66.7	77.8	61.1	59.7			

*χ^2 *tests of independence with different distances from the brick field*

3.6.2 Brick industry provides employment opportunity to local people

Nearly 60% of the respondents agreed that brick industry provides employment opportunities for local people (Table 1) and these responses varied significantly with the distance they lived from the brick industry. Among those living closer than 500 m of brick industries stated more that the brick industry could not provide employment opportunities to local people than those living farther away from brick kilns. A stepwise linear regression analysis testing attitudes whether brick industry provides employment opportunity to local people as the dependent variable, with eight independent variables (Table 2), however, only three of them proved to be significant contributors to the variation. The variables, which significantly explained variations in this statement, were the monthly family income, household size, and education of the respondent. The other independent variables were insignificant. All the independent variables explained 60.4 % of the variation of people's attitudes related to this statement. Respondents with a comparatively better financial condition, smaller than larger households and illiterate more than literate agreed more with the statement (Table 2).

Table 2: Linear regression analysis with people's attitude towards the brick industry in Raozan subdistrict

Independent variable	Brick industry should be technologically modernized		Brick industry provides employment opportunity to local people	
	t	**p**	**t**	**p**
Constant	5.189	**0.0001**	5.242	**0.0001**
Distance lived from brick field	-2.533	**0.014**	0.143	0.870
Gender	0.127	0.899	1.233	0.914
Monthly family income	0.677	0.501	9.437	**0.0001**
Household size	0.917	0.363	-4.437	**0.0001**
Occupation	1.146	0.256	0.631	0.815
Medical expenses	2.236	**0.029**	0.993	0.708
Education	-0.422	0.674	-3.961	**0.0001**
Age	0.449	0.655	0.006	0.209
R^2	0.153		0.604	

IV. DISCUSSION

Currently, the brick sector is largely growing by changing existing kilns, with the slightest variation in the design or operation of the kiln [7]. Construction costs of higher-emission and lower-efficiency Fixed Chimney Kiln is comparatively lower than coal-based Zigzag Kiln, as reported in this study. Thus, current owners of the

fixed chimney kilns are less likely to adopt modern technology in their industries [8 & 9]. It has been noticed in the study area, that some kiln owners have raised the chimney height when they found the poor emission levels from both Fixed Chimney Kiln and Zigzag Kiln.

Brick-making is a seasonal activity throughout the country, as brick kilns, such as fixed chimney kilns, and zigzag kilns, are often located in flooded lowlands during the monsoon. Thus, operational duration of the brick industry is on average about five to six months a year. During the monsoon season (i.e., off-season), frequent rainfall, high humidity and reduced sunshine decrease the production of bricks significantly (pers. comm. with kiln owners, Raozan in 2017). Employment in brick kilns is, therefore, also seasonal, but some manufacturers overproduce the green bricks during the dry season and keep them in shade during the rainy season. This requires adequate storage facilities and soil production in the off-season, which is costly and extremely difficult during the monsoon.

It is difficult for brick manufacturers to attract people to work in the brick industry. This is partly due to poor working conditions and low wages. Many workers, especially skilled ones, are eager for better wages. Most migrants work in brick industries for lack of a better alternative. They usually perform unskilled, low-wage work, requiring hard physical labour (e.g., mud-pugging by foot, brick-molding by hand, and carrying head-loads of bricks) for long hours. Many women are also working in the brick industry, but the workers in the brick industry are not organised and they are not able to promote their interests due to lack of trade unions. In many cases, the workers migrated with the family temporarily and took up residence near the brick kiln. Sanitary conditions are often abysmal in these types of habitats. Furthermore, high levels of air pollution in the kiln region are hazardous to the health of the workers [10]. Overall, severe physical exertion and unsafe conditions result in health problems for workers in the short and long term [11]. Also, immigrant families bring in around 30-50 children. Although prohibited by law, some children often join in the work to increase the income of their families, while in the village children can be admitted free of cost to the government primary school. In most cases, children are paid less than adults.

The brick industry is energy intensive in Bangladesh and consumes about 50% of the cost of production [12]. Brick kilns are fired using various sources of energy, which include fuelwood, coal, and natural gas. Natural gas is the cheapest energy source for the brick industry, but it was banned for the use of non-mechanical brick industry. Fuelwood can also be cheap fuel depending on its source. Firewood is banned as a source of energy for forest protection, but it is still widely used by the industry, as evident from this study, even though fines sometimes imposed by the Department of Environment. Coals are also widely used, but from time to time there is a problem with the availability and quality of coal which has obviously declined over the last few years. However, the wood comes from a number of sources: home gardens, land-clearing sites, and sawdust slabs. A portion of the fuelwood supply may still result from illegal entry into the forest, which further damages the environment [13]. Coal prices are steadily rising, while the quality of coal has dropped and oil has proved to be very expensive for the most of brick industries. Although Bangladesh produces high- quality coal with low sulphur content (e.g., less than 6.5 percent), virtually all of these are used for mining power plant, and, thus, are unavailable for brick kiln [14]. Sometimes, during the non-operational period of the power plant, local coal is available for brick kilns [15 & 16].

Clay is the main raw material for green brick production. In many cases, the soil is available from the land, which also has an agricultural value. Topsoil can be removed and set aside to be returned after clay removal -- an option which would have minimal impact on agriculture [17], but in practice this is often not done in many cases as observed in the study area. When the soil is removed, holes and land are abandoned. Peat is sometimes used as a fishpond, but in reality, often the land is lost for agriculture. It is common for relocation of brick factories when such a soil source has been lost, as observed in the Raozan subdistrict.

The inability to change the current state of the brick industry in Bangladesh includes lack of support controls, financial incentives and lack of standards to encourage more energy efficient practices and technologies. The government has made little effort to set effective border emission standards, except for a few attempts to control the sector [18]. Besides, there is little or no government activity to help the brick sector undertake elaborate programmes, so that it becomes cleaner and more profitable, but there is lack of knowledge and access to energy-efficient technology, which can lower production costs at the same time. Extensive dissemination activities, that demonstrate the potential economic benefits of energy-efficient technology, have not yet been carried out. However, the government should recognise brick kilns as a formal industry. This will enable easy access to financial companies, which in turn will enable investment in cleaner technology and advanced work

situations. In addition, the government should improve the working conditions of high-level mechanszation, social programmes to reduce child labour, occupational protection, and health care in kilns, besides setting up industrial parks to coordinate large numbers of industries in the land free of floods. In addition, the existing rules and policies, such as the ban on conventional high pollutant kilns (such as fixed chimney kilns), should be enforced by the Department of Environment of the Government of Bangladesh, and the introduction of rules and policies that encourage adoption. Moreover, the government and NGOs can create opportunity for the owners of the brick industry through providing the availability of subsidised credit and the convenient cleaner technology for adoption.

V. CONCLUSIONS

An important factor to consider is that there is a growing need for housing in urban as well as rural areas. The brick sector of Bangladesh is characterised by the dominance of small-scale brick industries with low energy efficiency and high emissions, low mechanisation rates, limited financial affordability and the dominance of single raw materials (i.e., clay) and products (i.e., hard clay brick). The adoption of gas-based cleaner technology is hampered by severe energy shortages and land scarcity. There is every reason to improve Bangladesh's own brick sector to save valuable natural resources, reduce air pollution, and improve energy efficiency. The government has already made rules that prohibit the use of fuelwood and fixed chimney kills, and have reconsidered the location and height of brick-kiln chimneys but the transformative development of the brick industry has not yet taken place.

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REFERENCES

[1]. SH. Rahman, D. Khanam, TM. Adyel, MS. Islam, MA. Ahsan, and MA. Akbor. Assessment of heavy metal contamination of agricultural soil around Dhaka Export Processing Zone (DEPZ), Bangladesh: implication of seasonal variation and indices, *Applied Sciences*, 2 (4), 2012, 584-601.

[2]. BBS, Statistical pocketbook of Bangladesh, Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, People's Republic of Bangladesh; 2011.

[3]. UNDP-GEF. Improving kiln efficiency for the brick making industries in Bangladesh: project fact sheet - PDF B Phase (UNDP-GEF-BGD/04/014, 2005), United Nations Development Programme-Global Environment Facility (UNDP/GEF); 2006.

[4]. BUET. Small study on air quality impacts of the north Dhaka brickfield cluster by modeling of emissions and suggestions for mitigation measures including financing models. Final report, prepared by Chemical Engineering Department, Bangladesh University of Engineering and Technology; 2007.

[5]. ESMAP. Introducing energy efficient technologies in the brick sector of Bangladesh. Energy Sector Management Assistance Program (ESMAP), Environment, Climate Change and Water Resources Unit of World Bank, South Asia Region; 2011.

[6]. BBMOA. Souvenirs of annual general meeting. Bangladesh Brick Manufacturing Owners Association; 2011 & 2012.

[7]. DA-PA. Brick kilns emission management: cleaner technologies and practices for Bangladesh brick sector. Development Alternatives-Practical Action, PHRD-funded initiative submitted to CASE project. Final Report; 2009.

[8]. Bangladesh Bank. People's Republic of Bangladesh: financing brick kiln efficiency improvement project. Bangladesh Bank; 2012.

[9]. E. Gomes, and I. Hossain. Transition from traditional brick manufacturing to more sustainable practices, *Energy for Sustainable Development*, VII (2), 2003, 66-76.

[10]. BA Begum, SK. Biswas, and PK. Hopke. Key issues in controlling air pollutants in Dhaka, Bangladesh, *Atmospheric Environment*, 45(40), 2013, 7705-7713.

[11]. M. Nordin, GBJ. Andersson, and MH. Pope. Musculoskeletal disorders in the workplace: principles and practice, *Elsevier Health Sciences*, 2006. p. 428.

[12]. A. Khan. Energy and stack emission monitoring in Hybrid Hoffmann Kiln (HHK). The World Bank; 2008. p. 35.

[13]. MD. Miah, and SA. Alam. Deforestation and greenhouse gas emission due to the consumption of wood fuel by the brickfields of Hathazari upazilla, Chittagong, Bangladesh, *Jahangirnagar University Journal of Science*, 25, 2002, 127-136.

[14]. MoF. Power and energy sector road map. Finance Division, Ministry of Finance, Bangladesh Government; 2012.

[15]. World Bank. Energy and stack emission monitoring in Hybrid Hoffmann Kiln (HHK) type, Universal Kiln, Final report. The World Bank, Dhaka,; 2008.
[16]. BM. Skinder, AQ Sheikh, AK. Pandit, and BA. Gana. Brick kiln emissions and its environmental impact: a review, *Journal of Ecology and the Natural Environment*, 6(1), 2014, 1-11.
[17]. FAO. Status and development issues of the brick industry in Asia. Food and Agriculture Organization of the United Nations; 1993. p. 1-73.
[18]. S. Maithel, R. Uma, A. Kumar, and N. Vasudevan. Energy conservation and pollution control in brick kilns. Tata Energy Research Institute, New Delhi, Paper presented at workshop organized by National Institute of Small Mines, Calcutta; 1999.