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RESEARCH ARTICLE

Black carbon and other pollutants from brickfields country-wise: Impact assessment and policy guidance under welfare analysis

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Abstract: The brick industry in developing world is a vast, coal burning and polluting industry. Nearly 1,500 billion bricks are produced globally each year where 87% are from Asia. China dominates the world in producing bricks using coal combustion and woods as fuels where Australia placed the last. Bangladesh placed the 5th in the world, and it mostly uses woods as fuels. These industries are owned privately. It is a type of industry that is mostly driven with business mentality without emphasizing the hygiene and health aspects where government laws are barely active in practices where rapid urbanization has been increasing demand of bricks. But, in most cases, this industry uses inefficient and dirty technology that causes environmental externalities. Brick-kilns inject huge volume of effluent gases. It causes depletion of atmospheric O_2 level. Addressing the issue for policy guidance, this study first analyzes the consequences of these externalities in terms of marginal damage (MD) under neoclassical partial equilibrium demand & supply theory. It further analyzes the reasons of disparity between social-cost and private-cost by conventional marginal damage analysis. Findings show that due to gases emission from brickfields, the marginal social-costs are higher than marginal private-cost. In this economic *dilemma*, brick-kilns are benefiting with the expense of human-society country-wise. As it has been going on, the rises of brick-prices have been causing upward trends of welfare losses where producer surplus is dominating the total surplus. This consequential economic situation has been causing higher deadweight loss year after year. The reason is that the bricks-customers distribute this expenditure away from now more expensive bricks. Now there is an urgency for national policy actions for ensuring cleaner & sustainable brick production. On this aspect, reforestation efforts can be achieved in multi-faucets including brickfields' charity and govt. policies on planting trees and for motivational efforts inspiring citizens of this country. These motivational efforts can be in multi-faucets: (a) inspiring "birthday celebration by planting trees", (b) forcing to use green Tech in brick kilns and (c) conducting research in both phases of govt. and academicians where financial supports can be inspirational.

Keywords: brick kilns, effluent gases emission, social costs, government policies

1 Introduction

The brick industry in developing world is a vast, coal burning and polluting industry. It is almost entirely lacking automation. Nearly 1,500 billion bricks are produced globally each year where almost 1,300 billion bricks (or 87%) are from Asia [1]. Here rapid growth of urbanization with an average rate of 6 percent has been driving the increasing demand for brick where solid and fired clay bricks are among the most widely used building materials [1]. In this progression, brick-usages are widespread practices in South Asian Countries. It requires a large scale of brick production meeting the demand in this part of the world. Bangladesh, a Southeast Asian country, is the second highest brick producer after India. It has been contributing over one percent of the country's GDP [2] and generating employment for about two million people even though vast majority of these kilns that use outdated technologies.

The labor-intensive exercise of hand molding clay into bricks (Hand-made bricks), is the predominant way of shaping green bricks in developing countries. In contrast, bricks in the developed world are machine-made, fired in highly automated electricity-dependent tunnel kilns using a skilled labor force, which causes low level of pollution. The brick sector in developing countries is generally labor intensive and non-mechanized. This traditional brick-making process in countries such as Bangladesh causes high-level of pollution, and it injects gases into atmosphere. Particularly, the process of burning wood & coal in brick-kilns produces elevated level of SO_2, NO_x, CO_2, CO and CH_4 gases. Thus, brickfields emit them into atmosphere, which depletes atmospheric level of O_2. In last past 10 years, the percentage of CO_2 emission level from brickfields was 82.784 [3].

Addressing the issue for policy guidance, this study first analyzes the impact of effluent gases emitted from brickfields in terms of marginal damage (MD) under the neoclassical partial equilibrium demand & supply theory [4–7]. Besides this, it analyzes the reasons of the disparity between social-cost and private-cost using conventional marginal damage analysis [5, 8, 9]. So, this study expects that the findings serve as a guidance for effective policy-design in Bangladesh and beyond addressing the issue.

1.1 Problem statement based on the reality

Among other gases, CO_2 is a sizable part of effluent gases injected into atmosphere from the brickfields. It is one of a major contributors of greenhouse gas (GHG) emission into atmosphere. Studies found that CO_2 emission plays a critical role in accelerating global warming trends [10]. Furthermore, the Model of Global Warming suggests that an increase in emission level leads to an increasing oceanic vaporization, which results a warming cycle [10]. (see Figure 1)

Source: Daily Sun, 20/01/19 and Rahman, 2022e

Figure 1 Brickfields at a glance.

Here in Bangladesh, the major source of effluent gases emission is wood and coal combustion that are used in multi-faucets [11] in peoples' daily lifestyle. The current study has chosen only brickfield as a source of affluent gases emissions in Bangladesh.

This traditional brick making is held to manage a host of accompanying perils. There is no doubt that besides affecting the environment, the process used in brick making is one that adversely affects the ecosystem in Bangladesh. It also damages more, which leaves a harmful impact on livelihood and in cultivation process in the globe. This is particularly so when it comes traditional brick making practices here. Bangladesh stands as the fourth largest brick producer in the world. Brick-kiln industry accounts for approximately 1% of the country's GDP. Bangladesh currently has a population of 160 million and at current growth rate, Bangladesh will require constructing approximate four million new houses annually to meet the demands of the growing population. It will lead the growth for the brick sector as years ahead. Table 1 supplies a snapshot of brick sector as of May 2020 in country-wise [1].

Table 1 Brick production in world

Country	Production %	Billion
China	66.67	1000
India	13.33	200
Pakistan	3.0	45
Vietnam	1.67	25
Bangladesh	1.13	17
Nepal	0.40	6
Rest of Asia	0.47	7
Total Asia	86.67	1300
USA	0.53	8
UK	0.37	4
Australia	0.13	2
Rest of world	12.40	186
Total rest of world includes Latin America	13.33	200
Global Prod.	100	1500

Source: Hablakilns.com, 2020

Table 1 shows that China dominates the world in producing bricks using coal combustion and woods as fuels where Australia placed the last [1]. When it comes brick production Bangladesh placed the 5^{th} in the world and it mostly uses woods and coal as fuels. Since there are many unregistered brick-kilns mainly located in rural areas [9], these kilns are out of regulation. It

mostly uses wood as fuel, which causes huge effluent gases including SO_2, NO_x, CO_2, CO and CH_4 gases and produced black smoke. This study uses Bangladesh *scenario* as a case study for impact assessment and policy guidance.

As Department of Environment (DoE), Government of Bangladesh reported, in year 2020, there were total 7000 kilns in Bangladesh, which had produced 23 billion of bricks annually where the value of the output was $ 2.53 billion and total coal consumption was 5.7 million tons. These brickfields injected 16 million tons of CO_2 into atmosphere [9]. Because the brick-industry has been using inefficient, dirty technology and informal seasonal employment methods for extended period, it has created a huge environmental problem [2, 6]. This ongoing dilemma has been affecting on human health, agricultural yields, and causing global warming. To undermine the level of emission, authorities concerned put the blame on brick-field-owners for being unable to efficiently prevent the kilns from emitting black smoke.

It is obvious that because of the existence laws, which is weak in practice, little over 12,000 brickfields across the country are running in conventional methods [2]. All these brick kilns are using wood and coal to burn bricks, damaging arable land by cutting earth and polluting the air by emission, while other brickfields have been running just without approval of Dept of Environment (DoE) under the Ministry of Environment and Forest, Bangladesh.

However, the DoE headquarters do not have specific data on the number of brickfields currently running in the country and the extent of pollution – the volume of emitted smoke and impact of its contents on human, and crops, vegetation, and land. But a World Bank study released last year found that in the North Dhaka cluster, brick kilns are the city's main source of fine particulate pollution, accounting for approximately 50 percent of total emissions during the 5-month operating period. The environmental regulator says the harmful brick-kilns running around Dhaka city and other places across the country had been set up after securing approvals through muscle power.

Global survey conducted recently shows that Bangladesh ranked 131st among 132 countries in controlling air pollution about its effect on human health. India holds the very last position (Financial Express, October 18 of 2020).

1.2 Environmental compliance and enforcement in Bangladesh

The Environment Conservation Act, 1995 (ECA 1995) of Bangladesh and Environment Conservation Rules, 1997 (ECR 1997) guide the Environmental Regulatory Regime to set up environmental administration in Bangladesh. It gives DOE a mandate for their enforcement. The DoE officials are often engaged in different activities to enforce the provisions of laws and rules as provided in the ECA, 1995 and ECR, 1997.

In practice, the DoE routinely conducts compliance monitoring of industries and development projects to ensure that they have been set up or undertaken after having Environmental Clearance Certificates (ECC) from the DoE as mandated by ECA 1995. The DoE also enforces environmental quality standards and management of those industrial-units and project as stipulated in the Environment Conservation Rules, 1997 and the conditions set out in the ECC.

Underpinning Section 7 of the Bangladesh Environment Conservation Act 1995, compensation is collected for the environmental damage caused by brick-kilns. Based on this regulatory provision, from June 2016 to June 2017 the DoE conducted enforcement drive against thirty-eight brickfields in which a total of Taka 120 million was assessed as compensation in which Taka 8.5 million was realized.

Besides this, enforcement activities are conducted against illegal brick-kilns under the Mobile Court Act, 2009 under which penalty is imposed instantly by taking cognizance of the offences. In last year, the mobile court fined a total of twenty-seven brick fields Taka 8.7 million for running the kilns without having ECC and Brick Manufacturing Licenses. While this effort was going on, a total of twenty-nine brick kilns set up without environmental clearance certificates were knocked down by the DoE. But several newspaper medias have reported that a considerable number of brick kilns are not registered (Financial Express, Dec 07, 2019; The Daily Star, Jan 04, 2020).

1.3 Objectives of the study

(1) To tip-off on how to bring the brickfield effluent gases issues to policymakers' attentions.

(2) To communicate on guidance for policy-design using Welfare Analysis in Bangladesh perspective.

2 Methodology

Methodologies that are used in this study are Marginal Damage Analysis and the Standard Partial Equilibrium Models. This study assumes as follows:

(1) Effluent gases emission is external and the effluent gases, *especially*, CO_2 concentrated environment or environment quality is priced like a regular public good;

(2) There are "n" number competitive markets for the emission free environment;

(3) For simplifying the analysis, both export and import of this good (bricks) are small or nonexistent;

(4) There exists rivalry among consumer preferences for having better environment;

(5) Exclusivity exists;

(6) The changes in emission level caused by changing the input level (wood or coal) and productivity and the change in demand for improved environmental quality (less pollution) by increasing income, population and lifestyle or preference over time are ignored. As empirically reported, the increases of population, income and lifestyle preferences increased the supply and demand for having better quality of environment.

These assumptions ensure that the aggregate demand for improved environment can be viewed as a negatively sloped schedule of the demand for improved environment at various prices holding income and taste level are being constant. It further ensures that the aggregate supply curve could be drawn as a positive sloped function, holding other prices, cost, and technology unchanged. Given the assumptions, the 'n' demand functions of Bangladeshis for improved environment, are the function of n prices which are completely decided. Saying another way, Bangladesh can be considered as a single market for quality of the environment.

Consumer surplus (CS) concept is used to capture consumer welfare changes resulting from a price change in bricks. Here the Marshallian demand curve is used to approximate change although the Hicksian demand curve would be theoretically better. But the difference between Marshallian measurement and Hicksian measurement is not important if the following three conditions are satisfied [12, 13]:

(1) There is identical consumer when it comes clean air facilitation being a part of the society;

(2) In this one market, there is only one price change;

(3) Because the bricks are products of manufacturing, the income effect is small. If all these conditions are met, then the observed demand behavior can be used to construct a measure of welfare change.

In this study, the assumption of "n" identical consumers approximates Bangladeshis where the "traditional match up behavior" makes consumption patterns homogeneous [12, 13].

Thus, for a single price change, the percentage of *error* resulting from using CS in the order of CY/2M which is likely to be small (CY = consumer income, M= consumer's constant income.). So, in the static partial equilibrium model, the size of inefficiency of the efforts modernizing brick-kilns for the improved environment purchase and supply system can be measured by the deadweight loss [7].

3 Results

3.1 The problem of emission from brickfields

Reflecting the emission problem in Bangladesh from brickfields into our framework, the Fig 1 is drawn in such way that is problem. It is assumed that brickfield "A" produces Q_1 number bricks. The production of bricks generates input costs, which are costs for both producer and society. Furthermore, there is a set of costs attributable to pollution generated by this brickfield industry, which is borne by Bangladeshis and not by brickfield "A". This situation creates a divergence between private-cost and social-cost that are also shown in Figure 2.

In this assessment, the social cost includes added costs consisting of the damages generated by effluent gases emitted by the brickfield "A" while producing bricks. In Fig 1, Q_1 number of bricks is total production corresponding to condition of MPC = MPB where MPC = marginal private cost and MPB = marginal private benefit. This Q_1 is greater than socially optimal level of output Q^* corresponding to the MSC = MSB.

In this case, the excess cost (EC) = $(Q_1 - Q^*) * (P_2 - P_1)$ is the cost to Bangladeshis for having this higher level of output than optimal level. Considering all brickfields in Bangladesh, the total excess cost is EC_{BD} = n * $(Q_1 - Q^*) * (P_2 - P_1)$. This represents as the total damages, which is caused by pollution generated from n number of brickfields by degrading the environment in Bangladesh. In Figure 3, the area "e" is total damages in Bangladesh by the brickfields.

The total resource costs are examined in Figure 4. Here resource cost associated with Q_1 is the area OBQ_1. The area OP_1BQ_1 is the benefit gained by Bangladeshi society from having the resources used in 'n' brickfields in Bangladesh. The area OQ_1B is opportunity cost. Here, net value = area OBE, PS = P_1OB and CS = EP_1B. Considering Figure 2, Q^* pieces of bricks production guarantees Bangladeshis a pollution free environment but they will have to spend as a whole n * $(P_2 - P_1)$. The welfare loss for this higher cost is shown in Figure 5.

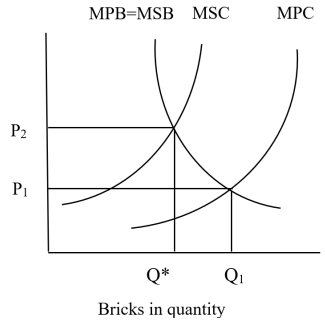

Figure 2 Market failure when Brickfields are not regulated in Bangladesh. MSC: Marginal social costs; MPC: Marginal private costs; MPB: Marginal private benefits; MSB: Marginal social benefits; Q^*: Bricks production with no emission; Q1: Bricks production and causing emission.

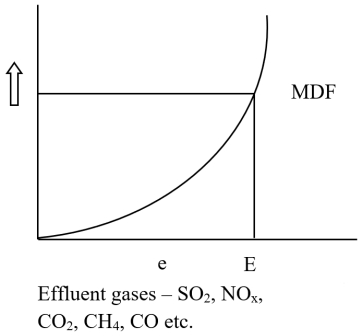

Figure 3 Effluent gases injected from brickfield in Bangladesh. MDF: Marginal damage function.

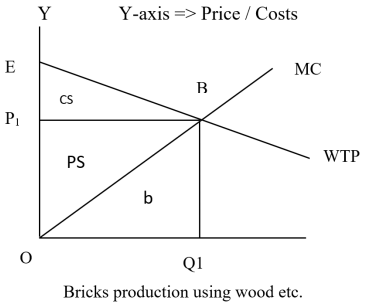

Figure 4 Resource cost for producing bricks. MCP: Marginal cost for the brick-kiln; WTP: Willingness to pay; CS: Consumer surplus; PS: Producer surplus; B: Resource cost or Opportunity cost.

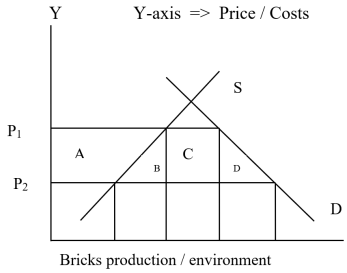

Figure 5 Welfare aspects of producing bricks with effluent gases emission. BS: Brick supply; BD: Brick demand.

In this *scenario*, the changes in price cause changes in CS. Price changes from P_1 to P_2 causes CS drops equal to the area (A+B+C+D). On the other hand, PS increases by the area A which directly goes to brickfields' owners. The area B is variable input cost. The area (C + D) is "deadweight" losses because consumers distribute this expenditure away from now more expensive Q_1 number of bricks usages. It can also be represented as Bangladeshi's real income loss for having a pollution free environment. It is noted here that the relative size of (C + D)

depends on the magnitudes of the induced price changes and the price elasticity of supply and demand.

3.2 Feasible options undermining emission-level from brickfields

The goal of this section is to look for probable options abating effluent gases namely CO_2, CO, NO_x, SO_2 and CH_4 emission from brickfields in Bangladesh. The emission of CO_2significantly dominates the Global Warming issues.

3.2.1 Reforestation or replantation

Replantation is an act of restoring indigenous forests to lands originally covered by forest. Studies found that replantation is one of the important options in reducing the level of CO_2 in the atmosphere because it significantly mitigates level of CO_2 emissions [14]. Planting trees can be used to control or sequester level of CO_2 in the atmosphere.

Hence, increasing the number of trees or plants and thus increasing the rate of photosynthesis may increase biological fixation of CO_2 level and other effluent gases emit from brickfields. Applying this reforestation idea into welfare analysis, which is shown in Figure 6, let us assume brick-kiln companies or government makes the tree planting decision setting MPC = MPB.

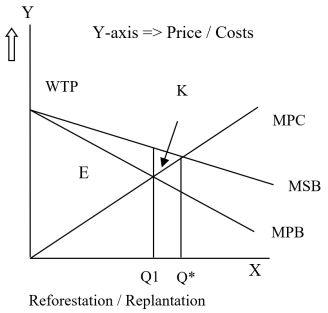

Figure 6 Welfare / Benefit from replantation

The corresponding market level of replantation is $Q_{1,}$ and optimal level is Q^* (for Bangladeshis) that are generated by reducing soil erosion, higher degree of better environment. The area "K" is Net Social Gains that are generated by planting trees. The following approaches can be recommended underpinning the findings of this study.

(1) If the industry takes part in planting, then it can pay the planting cost as a charity to the society where DoE will monitor the actuality in practice. Also, DoE can issue a Report Card and congratulate the industry issue a Certificate.

(2) If government takes part in planting, then government will collect these costs or taxes from the brickfield companies that manage emitting effluent gases in Bangladesh. In this case environmental clean- up or pollution prevention is a task for the government like any other public infrastructure (road, telecommunications etc.). This dual approach ratifies sharing the cost among Bangladeshis for ensuring a better environment, which can ensure a win-win results for all parties involved.

(3) Government can encourage people in different ages to celebrate individual birthday by planting a tree beside roads & highways and near train-lines with the approval of local assigned officer(s) under DoE. In this process, DoE can issue Celebration Certificate, which can be a win-win to all parties involved. This message can be communicated *via* schools, colleges, and universities for ensuring effective and continuous outcome. It can ensure a greater return for the efforts it may need for implementing the theme.

(4) Delivering motivational message should be strengthened that a forestation is a social and moral obligation for every citizen. It should begin with introducing the message in institutional education system. Also, it should be promoted on TV and Radio medias.

(5) Research on finding fast-growing species of trees, having better fuel and timber values should be strengthened keeping local climate and social condition in view. Also, research on discovering techniques for use the waste-product of sugarcane should be conducted. Besides the contribution of curtailing the magnitudes of emission level, it can be a win-win for the parties involved.

Government subsidies or company's charity as shown in Figure 7, the area (A+B+C+D+E) is consumer surplus where company pays area (A+E) as charity. Government subsidies are area (E+B+C+D+F), which is collected from Bangladeshis as taxes. Net loss to Bangladeshis is equal to area (E+F). Area E reflects a net loss of producer surplus, which is evolved from underutilized resources, subsidies, or charity. The area F is deadweight loss that is just lost, which cannot be recovered.

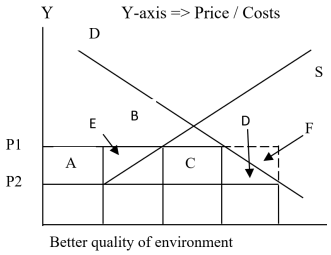

Figure 7 Welfare or benefit from better quality environment via Govt. subsidies & company charity

3.2.2 Taxation for ensuring better environment

The taxation policy is a great tool for controlling economic-growth activity. This is because the imposition of a tax can acts as a catalyst to create incentives for investment in curtailing levels of emissions including CO_2emission (Denver and Nixon, 1989). In practice, the basis of taxation may differ. Thus, addressing emission from brickfield including CO_2 emission reduction in Bangladesh, new taxes can be based on the rate of emission, not taxes on number of bricks produced. Despites the fact that taxes on bricks can necessarily cause a reduction of gases including $CO_2$from the brickfields, this study examines only the option "taxes on emission" The term "taxes on emission" can also be represented as an abatement-cost.

Under taxation policy, emission abatement level can be decided by setting MD = MAC where MAC represents marginal abatement cost as it is shown in Figure 8. Here, emission level is set to E_1, and it is curtail-able *via* gases including CO_2 sinks in the atmosphere. Brickfield "A" abates E1 / "n' units *via* government relevant regulations.

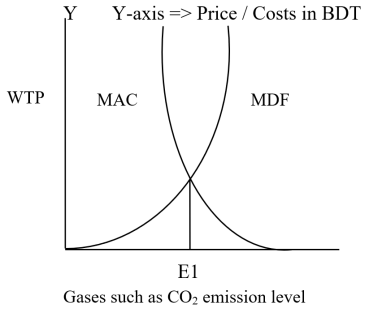

Figure 8 CO_2 after regulations. MAC: Marginal abatement costs; MDF: Marginal damages function; E1: Optimal level of emission, which is consistent.

Assumptions include the followings:

(1) Government regularly checks each brick-kiln's level of emission for gases such as CO_2;

(2) Government is not aware about brickfield's marginal cost (MC), and it is ambiguous measuring in currency (Taka) of both marginal damages caused for gases emitted and marginal abatement cost needed for abating these emissions. The idea of optimal level of emission need not be static. This is because it may adjust over time, and it aids to overcome this constraint;

(3) Government sets the target at "a" in Figure 9 but brick industry suppose "A"s emission level is at E_2. As $E_2 > E_1$, thus, industry "A" pays taxes for $(E_2 - E_1)$ in a certain fashion.

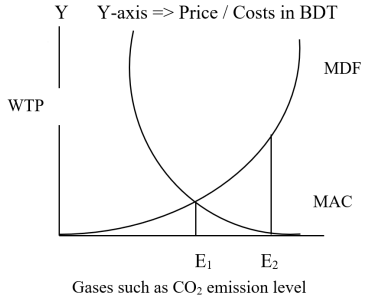

Figure 9 CO_2 emission under command & control. E1: Emission level under regulation; E2: Emission level produced by Brickfields.

The taxation-policy reduces PS by (A+B+C+D) in Figure 10. Variable inputs in this illustration move into other competitive technology or inputs in aim to improve plant's performance

and energy efficiency to minimize losses of PS. Now the question is: how does the PS-loss spread throughout the economy of Bangladesh?

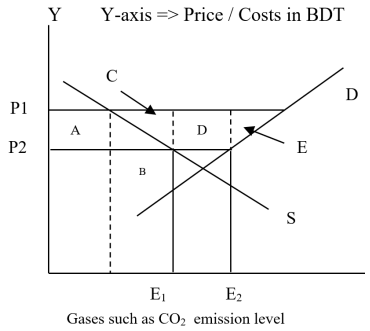

Figure 10 Welfare analysis under command & control. E1: Emission under regulation; E2: Brick-kiln industry produces.

The value (A + B) becomes an increased part in CS which interprets the improvement of environment comparing other environment where "command and control" is not in practice. The value "D" is picked up as tax-revenue, which is equivalent to the volume of ($E_2 - E_1$). This leaves triangles C and E to be accounted for. Here C is losing to the society, and it will be equal to *zero* by adjusting the target level over time. Area E is deadweight loss that cannot be picked up. It is just gone.

3.2.3 CO_2 emission control technology

The Clean Air and Sustainable Environment (CASE) project supports an entire range of activities including introduction of energy-efficient brick making technologies and is proving the viability of alternative building materials.

Technologies such as Improved Fixed Chimney Kiln (IFCK), Improved Zigzag Kiln (Zigzag), the Vertical Shaft Brick Kiln (VSBK), and the Hybrid Hoffmann Kiln (HHK) etc. are cleaner, consuming less energy and emit lower levels of pollutants and greenhouse gases (US Dept of Energy, 1993). In most of the methods, other than in HHK, coal is used as fuel to burn the bricks. The DoE officials showed that they would decide soon, which method is supposed to be in place. The regulator also suggests that the production of hollow block bricks needs to be prescribed, even though it is costlier, as the method contributes nothing harmful to the environment. Bricks are made with silt, cement, and stone crush, and later are dried in the sun. These bricks are soundproof and earthquake friendly.

3.2.4 Fuel switching and reappearing power plants

Gases including CO_2 emission can also be reduced by fuel-switching brickfields (Driver and Nixon, 1989). However, the question of cost effectiveness is a concern in this policy-option. In general, it is expensive to "scrub" carbon from combustion waste gases [15].

3.2.5 Clean coal technology

Clean coal technology shows using new & advanced coal use technologies. They are more efficient; thus, it can result a low-cost. They are more environmentalism sounds comparing to traditional coal burning exposure. The use of quality raw materials may also ease better kiln firing process overall. Development of green belt around the brick kiln industries may be an effective mitigation mechanism. Also, with clay, usages of sugarcane bagasse ash have been recommended as brick materials in literature [16]. It can be an instrumental curtailing the magnitudes of emission from brickfields in Bangladesh.

3.2.6 Monitoring number of brick kilns and conducts mobile court drive

National Strategy for Sustainable Brick Production in Bangladesh [17], Government Report shows that there is total seven thousand brick-kilns in Bangladesh. But report on total number of brick-kilns varies from government information to classified information. However, a newspaper, Financial Express reported that there are more than 11000 brick-kilns that are currently in operation in Bangladesh. In this total number a considerable number is not registered with the government (Financial express, Dec 03, 2019)

To overcome this *dilemma* in aim to curtail the magnitudes of emission level from brickfields, government should play active roles conducting Mobile Court Derives. This policy and effective efforts will be a win-win-win for the society. This is because it can ensure generating adequate revenues. On the same token, it can curtail magnitudes of emission, which can be appreciated

by many organizations such as UNO. So, the UNO would not be hesitated to grant monetary support underpinning Kyoto Protocol Agreement.

3.3 How to motivate policymakers for designing & adopting policies relate to brickfield?

In Bangladesh, the income level is rising, which has resulted rapid urbanization, which has resulted an increasing demand for residential, commercial, industrial, public buildings and other infrastructures. This development has resulted dramatic rise of brick manufacturing industry in Bangladesh. But this industry alone injects enormous volume of effluent gases. This is because they are using inefficient & dirty technology.

On the issue for national strategies and policy actions for cleaner and sustainable brick production, Bangladesh Government, introduced guidelines on national strategy for sustainable brick production in year 2017 [17]. The goal of this effort was to prepare a 'National Strategy Paper' and recommend policy actions for sustainable brick manufacturing industry.

With this progressive effort of government, it would not be unreasonable to ask: can policymakers of a nation, like Bangladesh, play role for better-ness of its modern-human-society in aim to meet environmental challenges in multi-faucets?

The answer to the question posed is, YES, where efforts of relevant industries or news-media can play significant roles in spreading message, which can be inspirational to policymakers sooner than further delays. Besides these traditional organizations, roles of academic institutions are crucial for conducting Academic Conferences or International Research Conferences on agenda(s) such as:

(1) Needs for rapid growth of use green tech in brick industry sooner than further negligence in actions;

(2) Raising awareness and engaging the public, officials, and policy makers in support of policy-designs underpinning slogan "we can do better for the society as a whole" which can promote use of green tech than before in Bangladesh;

(3) Inspiring brick-kilns in Bangladesh or brick industries globally for encouraging or for hosting conferences on the proposal where roles of United Nations Organization (UNO) can be crucial in practice in case of global efforts.

3.4 Who should finance or sponsor the proposed conferences?

Agenda-setting is a crucial element of the strategies that political actors pursue [18]. Agenda-setting is an important part for politicians, officials, and interest groups for policymaking. This is because getting an issue to be considered is a precondition for decision-making, which requires gaining attention of the issue.

On the same token, publication or proposal in literature does not guarantee its application or agenda setting in practice unless policymakers are engaged for designing relevant policies addressing the issue in general. The process of setting agenda for policymakers' attentions in any country goes through various challenges [19]. However, there are two distinct challenges. They are as follows:

(1) Gaining attention for the issue;

(2) Building sufficient credibility for the nation to deal with the issue for society-interest.

Gaining attention is a crucial element in all agenda-setting processes. Here mobilization of interest is what agenda-setting is about. Since this effort is *parallel* to the theme of global movement – Kyoto Protocol, UNO and brick industries in a country or countries would contribute directly for development of policy communities by subsidizing interest groups. These groups will push for the issue at the national level. It has become a widespread practice in countries globally when it comes public interest issues [20].

Furthermore, academicians' efforts can be used hosting conferences. Their efforts on relevant publication can play significant roles spreading messages, which can be inspirational to policymakers sooner than further delays. But it must require delivering the message directly to policymakers individually.

In addition, both the brick-kiln sector and interest groups themselves actively will try to develop networks of experts and stakeholders within its nation for relevant policy-design. . The brick industry sector can do so by meeting groups on having use of green tech in practice meeting the demands of 21^{st} Century technology-driven world where academicians in the field can be tapping into presenting the proposal to policy-practitioners.

3.5 Future research

Studies can be conducted in multi-faucets examining the possibility of use of green tech in brick manufacturing industry using opinion-survey of management & employees of the

brick-kilns in Bangladesh. However, research grants can be inspirational for investing research-efforts soon. Factor Analysis, hypothesis development & testing etc. can be conducted. Thus, the expected findings can be educational enhancing the growth of using green tech meeting the challenges. *Lastly*, welfare analysis can be conducted for individually clean-bricks-users, brick-kilns and for the society.

3.6 Conclusion

The brick industry in developing world is a vast, coal burning and polluting industry. Nearly 1,500 billion bricks are produced globally each year where 87% are from Asia. China dominates the world in producing bricks using coal combustion and woods as fuels where Australia placed the last and Bangladesh placed the 5^{th} in the world. Since the beginning of advancement, bricks have been playing important roles for construction of houses and other infrastructure in Asian countries where Bangladesh is no exception. Bricks are effort-able building material in urban areas of Bangladesh. In recent years, because of rural-to-urban migration, a rapid urbanization has created an increasing demand for bricks. As a result, the number of brickfields has risen dramatically. But this industry uses inefficient, dirty technology. As a result, it emits huge volume of effluent gases such as CO_2. More specifically, burning wood and coal in brick-kilns produces elevated level of SO_2, NO_x, CO_2, CO and CH_4. Thus, brickfields inject them into atmosphere and deplete atmospheric O_2. For impact assessment and then policy-guidance on the issue, this study analyzes the basic issues of gases emit from brickfields in terms of marginal damage (MD) analysis and the neoclassical partial equilibrium demand & supply theory. It analyzes the reasons of disparity between social-cost and private-cost by conventional marginal damage analysis technique. Findings show that because of gases emission from brickfields, the marginal social costs are higher than marginal private costs. Here brick-kilns are benefiting with the expense of Bangladeshi society. Continuation of increasing number of brick production under traditional fuels results higher welfare loss incurred from higher social costs. Also, because of high rise demand of bricks, the prices of bricks are becoming upward trends. It has been increasing PS. By using inefficient fuels in brick manufacturing industry, producers continue generating higher revenues and consumers face higher prices, which creates higher deadweight loss year after year. This unplanned development of the brick industry in Bangladesh is unsustainable. Thus, there is an urgency for national strategies and for policy actions for cleaner & sustainable brick production. Reforestation efforts can be achieved in multi-faucets including brickfields' charity, govt. policies on planting trees, govt.'s policies on motivational efforts inspiring citizens of this country. These motivational can be in multi-faucets: inspiring "birthday celebration of everyone by planting trees, forcing to use green tech in brick kilns. An inspiration for conducting research in both phases including govt. and academic arena are needed.

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