Assessing the Impact of Zig-Zag Technology on Physical Health of Local Residents: A Case Study of District Lahore

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CERTIFICATE

This is to certify that this thesis entitled: **"Assessing the Impact of Zig-Zag Technology on Physical Health of Local Residents: A Case Study of District Lahore".** submitted by Aneeqa Rehman is accepted in its present form by the Department of Environmental Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in **Master of Philosophy in Environmental Economics**.

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Contents

Abstract

Air pollution is an important element that is influenced by Climate. When air quality is reduced it directly affects the human health as well as the ecosystems. Many studies have indicated that climate change affects the air quality. The two main effects of climate on air quality is lessening the removing processes as well as increasing the atmospheric chemistry. The connection between human health and air quality is direct. People living in the areas which are polluted are more prone to respiratory diseases as well as skin infections as compared to people living in an area where the air quality is good. Carbon dioxide and black carbon are the one of the main gases which pollutes the environment, affects the climate change and bricks kilns are the primary source of it. Brick kilns affects the human health and degrades the air quality due to consumption of coal. In this study we have examined the effects of Zig-Zag technology on human health as compared to conventional brick kiln. We have taken the case study of district Lahore where this technology has been placed. The sample we chose of our respondents was 150 in which our control group was non brick kiln area and our treated group was Zig-Zag and conventional brick kilns with the radius of 3km. The survey identified that the people living near conventional brick kilns are more likely to be affected by a disease than the people living in Zig-Zag or non-brick kiln area.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The brick kiln industry is the biggest in the domain, has in excess of 73,000 working units, delivering around 900 billion sintered bricks every year (Wang X,2010). Bricks are the fundamental source of infrastructure development in little enterprises (Patra. P, 2015). Regardless extensive utilization of brick kilns, there have been very less research on the emanation effects of kiln design. Conventional Brick Kiln industry powered by coal (Maithel S et al,1999) is a source of hazardous discharge, made out of fine dust particles, Hydrocarbons, Sulfur Dioxide , Oxides of Nitrogen, Fluoride mixes, Carbon Monoxide, Small measure of cancer-causing dioxins, Aldehydes and Free radicals (Erbe and Oliver S,2011). These discoveries are in agreement with the past discoveries of Woodruff which expressed, word related and remaining presentation in connection to financial position may likewise be related with air contamination levels and can impact wellbeing antagonistically (Woodruff T. J et al, 2003). Concentrates in the respiratory strength of brick kiln laborers and bricks have demonstrated that perpetual bronchitis and decreasing lung work values are related with air contamination, particularly in the firing and uploading segment (Alam et al, 2009). The cluster of brick kilns are source of nearby air contamination aggravating neighborhood health, farming and vegetation, at worldwide level as they additionally add to environmental change (Ganguly et al,2015). In the presence of high density dust, high temperature and particulate matter over quite a while can bring about word related medical issues, including genuine infection (e.g. lung malignancy) Spies et al. (2006). The examinations demonstrate a steady disorder of work related eye, nose and throat disturbance trailed a little period by shortness of breath as given by (S. B. Gordon et al, 1998).

1.2 Brick Kiln

The brick kilns are growing quickly as it is the essential development material due to deficiency of stone aggregate. Due to these reasons, the demand for bricks has been increasing over the previous decade. (Das, S., Hasan et al. 2017). Bricks are cooked in ovens (kilns), and they are used amongst the most utilized types for building materials in the globe. The constant status of fired bricks as building material is an outcome of adaptability in development and desgin, price efficiency, flexibility in extreme conditions and its generally high versatility (Akinshipe, O. &, Kornelius, G. 2017). In several parts of the developing and rising economies, brick kilns of lesser scale are known as a source of urban air contamination. Kilns energy productivity is inefficient as well as it emits high level of polluting fuels such as dark carbon (BC), natural carbon (OC) and other climatic contaminations into neighborhood groups due to intense burning which poses extreme threat to the wellbeing of people and have ecological effects (Molina, L.T et al. 2013). Consumption of coal resulting in discharge of numerous air contaminations in environment, for example, carbon monoxide, sulfur dioxide, carbon dioxide, particulate matter and nitrogen oxides.These toxins are damaging for human wellbeing, plant and animal life in the vicinity of brick kilns and its surroundings. At worldwide level, contaminations like CO2 adds to the occurrence of dangerous environmental change and global warming. (Maithel, S et al. 1999). In spite of this significance, by far most of brick kilns practice obsolete, energy exhausting machineries that are exceeding polluting. Substituting the existing practices of brick kilns into cleaner technologies will help in reducing the effects of pollution on pre mature death by 45-60%(Croitoru, L. also, Sarraf, M. 2012).

1.3 Zigzag Brick Kiln

For this reason (Zig Zag) for brick kiln development was presented by the International Center for Integrated Mountain Development and model takes after the zigzag example of brick heating to

decrease the discharge of suspended particular material (SPM) into the climate. Under this model, bricks are laid in a zigzag framework while heating and the single-man-coal-sustaining framework is connected when bricks are prepared. This arrangement of heating bricks is accepted to expand wind stream inside brick stacks that guarantee viable and uniform consuming of coal, which at last diminishes dark carbon emanation from brick smokestacks. Alois Habla a German engineer invented the Habla Zig Zag Kiln. Its main characteristic is the long firing zone which is forced to move in zig-zag pattern through the stationary bricks, the draft is induced with the help of an axial flow fan. The technology allows even the most inferior fuels due to the long zig-zag firing zones. The heat available in the freshly burnt bricks is reclaimed and used to dry the green bricks before these are subject to firing zone. The low emission burning process helps mitigating the emission of greenhouse gases. The induced draft eliminates the need of chimney structure, which is quite expensive to build, thus the technology requires far less capital investment. Overall energy requirement for this type of kiln is very low, using less fuel for brick baking and almost negligible mechanical energy to operate the kiln. The kiln is capable of continuous operations for round the year. The flexible design can meet the requirements of small as well as medium enterprises. For quality construction and load bearing walls the bricks need to have adequate load bearing and crushing strength which is usually difficult to achieve through short firing cycle. The initial investment for Habla Kiln is lower than its cotemporary technologies, kiln maintenance requirements are almost negligible, operation can be opted from semi- continuous to continuous with varying production sizes and above all its adoptability to cheaper inferior fuels while still retaining efficiency and low pollution grade this kiln as most suitable to Pakistani context.

1.4 Brick kilns in Punjab

The brick kiln industry, with a predicted estimate of 1.5% input in the GDP, is an area which is poorly managed and un-recorded. In Punjab there are around 10,000 regular brick kilns. A large number of the brick kilns, manufacturing bricks, are situated around the urban communities of Pakistan. Thick dark clouds of smoke rising out of funnels of brick kilns can be seen floating over the nearby areas. Many of the brick kilns labors including children and women are equally exposed to the inhaling of polluted air, which poses serious health threats. These kilns produce thick dark smoke containing air contaminations such as (nitrogen oxides, carbon monoxide, carbon dioxide, sulfur dioxide) and fine particulate matter, which imposes genuine threat to the well-being of the people living in the nearby communities causing human illness, animal and plant decimation. The transformation of brick kiln offers enormous prospective for energy saving, decreasing black carbon and CO2 emissions, generating the profit in brick enterprise, lowering the degradation of agriculture land, improving work environment and well-being of labors, providing better and strengthened quality construction material for the consumers. The delegate of ICIMOD visiting Pakistan was of the view that 70% harmful outflows can be decreased through new technology and the fuel effectiveness can be 40% superior to traditional brick kilns.

1.5 Clean Development Mechanism

According to article 12 of Kyoto Protocol (KP), any sort of intentional reduce emission did in a Non Annex I nation can be utilized by an Annex I nation to meet its consistence with the outflow targets characterized under the Protocol. This offers ascend to an imaginative market system known as the Clean Development Mechanism (CDM). A wide range of energy efficiency change enhancement will prompt nearby and additionally offsite GHG emanation diminishments and these GHG discharge decreases, and therefore for the most part meet all requirements for the CDM. In

this manner obstacle can be evacuated through the market systems of the Kyoto Protocol (Ellis and Bosi 2000). The aggregate worldwide GHG discharge lessening focuses of Annex 1 nations under KP is evaluated to be 713 million t CO2 eq. from their 1990 outflow levels in the primary responsibility time frame Grubb et al. (2003), survey the discharge courses, local GHG outflow reduction and the supply capability of Hot Air and Joint Implementation and conventionally evaluation the worldwide CDM potential to be 50 to 180 million t CO2 eq for every year. While shoddy and simple decline from industrial GHGs will take the lion's offer of the CDM market in the short run, efficiency of energy ventures are probably going to take up a bigger offer in the long term. (Michaelowa A, Umamaheswaran K. 2006) fortunately there are an increasing amount of stages that can bolster a multi stakeholder discourse on co-benefits. The UNFCCC and the Kyoto Protocol's CDM make reference to advancing manageable improvement whereas alleviating greenhouse gases (in spite of the fact that not formally directing these substances) (Zusman E et al. 2013). The world has although revived the Kyoto protocol and its adaptability components worldwide on the forest as source for financial advancement and ecological administration but through reducing brick kiln emission we can likewise achieve the carbon credits. (lin JCM. 2006)

In the meantime, the as of late began UNFCCC Ad Hoc Working Group on the Durban Platform. Additionally, recently designed Climate & Clean Air Coalition have advanced the improvement of SLCP projects of mitigation and national action plan. On the territorial level, air contamination agreement, for example, the Acid Deposition Monitoring Network in East Asia , Potential Trans boundary Effects for South Asia, and Malé Declaration on Control and Prevention of Air Pollution could give bits of knowledge to emission and effects on SLCPs (Zusman E et al. 2013). Carbon sequestration ventures plan to produce carbon credits in light clean Development mechanism of Kyoto protocol Article 12 profiting agents, their lenders, and in addition individuals all inclusive.

The money related advantage of coal over biomass singe can conceivably be turned around if the biomass burn actuated carbon sequestration credit can be changed into item future and exchanged uninhibitedly later on advertise. (lin JCM. 2006). The past outcomes comprise of various sorts of data with respect to number of brick kiln, yearly measure of fuel utilization (flammable coal and gas) and carbon dioxide outflow from block ovens around the south asia and exhibited in the accompanying segments. As per Kyoto convention, being a creating nation it isn't compulsory for developing countries to decrease greenhouse discharge however clean improvement component (CDM) ought to be advanced in these nations. At long last, it is important for state to push individuals into making mindfulness against conventional kiln and make the innovation basically accessible to the brick makers. Print and electronic media shall approach in energize individuals for utilizing such sorts of brick. Additional showcasing is needed to acquaint individuals with environment friendly bricks and to decrease carbon emission for improved future and supportable advancement. (Imran MA et al. 2015)

1.6 Problem Statement

Development of modern technologies has been a key determinant to accelerate industrialization and urbanization in developing countries. As a result, environment pollution is tremendously increasing due to industrialization and mechanization that is serving to fulfill demands of population. With increasing population, demand for bricks for construction is also increasing (B. M. Skinder, 2014). The biggest mud block creating nations on the planet are China (54-67%), India (11-16%), Pakistan (3-8%), Bangladesh (1-4%) and Vietnam (~2%). Yearly worldwide brick generation is evaluated at 1.5 trillion bricks, with Asia representing (1.35 trillion). Brick production by conventional ways has become a serious health issue for the people living around the brickyard and also for the makers of bricks themselves. Brick kilns have been distinguished as

a standout amongst the major source of barometrical contamination. Air contamination result in a few issues, for example, health perils, particularly for ladies and youngsters, unfavorable consequences for agribusiness, animals, building material and structures, social and archeological landmarks. While air contamination is for the most part thought to be a urban phenomenon, it is turning into a country issue with the entrance of transport and development of industry and the development of brick kilns. In order to control for the brick kiln pollution, new technologies has been introduced which are believed to be reducing emissions and have beneficial health effects.

1.7: Research questions:

- Is there any emission reduction by Zigzag technology as compared to Conventional brick kilns/ non brick kiln area?
- Is there any relationship between air pollution from coal emissions and health problems?

1.8: Objectives:

The following will be the objectives of this research:

- To examine the economic feasibility of zigzag technology by CBA and IRR methods.
- To examine the impact of zigzag technology on physical health of households living in neighborhood.

1.9: Organization of Study:

The study is consisted of 6 chapter, first chapter is about the introduction of the thesis topic, problem statement, research question and objectives. Second chapter includes literature review which covers different components of the topic. Third chapter channels the theoretical framework. Fourth chapter includes study area, data size and collection, and method for conducting the evaluation method. Fifth chapters comprises on descriptive statistics and results on the basis of the data that has been collected. Sixth chapters covers the conclusion and recommendation of the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Brick Kilns and Workers

Brick kiln is a seasonal industry during the season it is very labor intense industry, which relies upon the monsoon season, and during the season most of the worker migrate from rural areas to work in it (Gupta, 2003). Workers require this for their survival, which is their only one asset in a situation described by adult joblessness. They don't have some other plausibility to make due aside from by contracting obligation from the labor broker (Rogaly et al. 2001). Mostly the underdeveloped countries who are depend on agriculture and unemployment and other local factors also push people to brick kilns industry (Kainth GS et al. 2009). Manual block influencing units to utilize a great many female laborers with a couple of male supporting staff (Mukhopadhyay P. 2008). The female laborers are persistently presented to the sun as well as are presented to an additional measure of warmth by radiation and convection in the brick kiln from both inside and outside (Sahu S et al. 2010). Female labors have particular pressure related disorder coming about because of occupation discrimination and a twofold weight of work (Saiyed HN. 2004). For instance, in the wake of work on the ground, male partners backpedal to have rest, yet the female laborers deals with the kids and prepare food for the household also. Once more, food and milk is given more to male partners than to the female. Therefore, male have a superior capacity to labor and give their full output than the females (Parsons KC. 2003). Lower vigorous capacities with regards to ladies build the relative workload of a given errand, and littler blood volumes in ladies result in higher heart rates (Kenney WL. 1985).

2.2 Socio-Economic life of Brick kiln workers

The brick kilns fill in as a wellspring of business for a large number of unskilled workers, the seasonal nature of the work pulls in migrant worker, a considerable lot of them landless farmers, children and females (Sharma DK et al. 2013). Social standards and financial substances imply that child labor is very common and accepted. Numerous families depend on the pay created by their youngsters for survival, so kid work is frequently much valued (Rana, M. furthermore, Das, A 2014), and Sizable portions of the workers are women. Block Industry is one of the casual/disorderly enterprises. This industry is blasting with the development of land business. It is a work escalated industry. The business emloys a huge number of labors the greater part of them are kids and females in developing countries (Das, R. 2015a).

The business is one of the biggest work producing ventures utilizing a large number of individuals. Brick kiln labor dependably stay under substantial work strain to work all the more proficiently for higher creation amid seasons with less resources and administration abilities (Das, R. 2015b). These laborers were generally unskilled or had essential instruction. Females were uneducated. These laborers are getting day by day compensation and there is no holidays accordingly. The days these labor don't work are non-paid days. All these labors whined of substantial torments (Sharma DK et al. 2013). Brick labors are known for weakness and poor access to human services. Workers health should be evaluated from time to time, to look for possible solution for provision of effective health care and occupational environment (Shewale, A et al. 2013).

This distressing circumstance turns out to be more awful by physical inconveniences in the work environment. Brick making is a worker intense industry utilizing kid as the real work drive. Laborers are required to utilize physical quality, convey overwhelming weight and stay in a hunched down stance for longer periods doing monotonous errands posturing dangers to

musculoskeletal framework (Das, R. 2015b). Moreover, bosses regularly like to employ kids since they are less expensive and thought to be more agreeable and dutiful than grown-ups (Rana, M. and Das, A 2014) so Children in these families are typically experiencing respiratory tract diseases, intestinal infections and diarrhea (Sharma DK et al. 2013). Working condition should be enhanced so workingwomen get roused and enthused that may bring about advancement of the kilns. Statutory advantages should be given for their welfare (Das, R. 2015a).

2.3 Environment and health

The high level of concentration of greenhouse gas in the air, ecosystem damage and environmental pollution is due to brick emissions (IUSS, 2002). It was found that brick kilns were located near agricultural lands and residential areas those were responsible for local community's health problems in great extent (Jerin, 2016). The health of the people and the air quality is degrading for the people who are living near the brick kilns. New studies shows that the particulate matter (PM) concentration in offseason is very low as compare to other season of brick kilns (Raut, 2003). Because of air contamination from kilns, communities are facing many diseases such as nasal issue, breath issue, eye irritation and others ailments. Around half of the respondents had confronted breath issue (Das, 2013). School kids living close-by brick kilns were suffered by upper respiratory tract toxicities like pharyngitis and tonsillitis which is very serious health condition (Joshi and Dudani, 2008). Results demonstrate that there are unfavorable impacts of these enterprises on soil, water, air, vegetation and human wellbeing (Rizwana Khan and Harish Vyas, 2008). The disastrous health impacts of air contamination are very much reported now in the epidemiological studies. Abnormal amounts of air contamination have been connected with many diseases, for example, heart disease, asthma, blood pressure, migraine, cancer, bronchitis and many more (rafiq et al). The brick kilns labors were observed and a high frequency of respiratory illness

was found among them. Age, nature of work and smoking were solid indicators of building up these side effects and sicknesses (sheik et al, 2012). The examination of respiratory symptoms among laborers demonstrated that most extreme side effects were of those who worked in unloading and fire sections (Meo et al, 1994). Poly-aromatic hydrocarbons are chemicals ordinarily present in smoke that causes nausea, looseness of the bowels, eye redness, while in extended period the exposure to these chemicals can result in liver and renal diseases and in some cases even cancer (Khan). Reports affirms that proceeded with exhibit levels of contamination will prompt higher occurrence of respiratory issues, particularly those in downwind territories (SKAT).

2.4 Carbon credits market and zigzag brick kiln

Asia delivers roughly 1.2 trillion blocks for each year (Heierli and Maithel, 2008). The worldwide block business is a noteworthy source of CO2 emission. Which exclude every kind of other input utilized amid block generation procedure or need the diesel through which we can transport the blocks. Only the coal devoured, the brick business in the main five Asian block delivering nation's produces 1.2% of aggregate worldwide anthropogenic CO2 discharges. Brick kilns are critical producers of dark carbon, also known to add to environmental alteration and many health related issues. Dark carbon and suspended particulate matter (SPM) contribute of a worldwide temperature alteration after CO2. In excess of 2.4 million unexpected losses can be ascribed to dark carbon consistently (Baron et al., 2009).

China contribute 54% of the world's blocks, trailed by India at 11%, Pakistan at 8%, and Bangladesh at 4% (Baum, 2010). Moreover, every country uses a wide range of kiln advancements. For instance, almost 90% blocks are delivered by China utilizing Hoffman kilns while 3,000 BTKs and 60,000 clam kiln are used by India (Heierli and Maithel, 2008). Since the manufacturing of bricks is exceptionally unregulated and non-authorized, which is hard to gauge

block generation from every sort of kilns and its related CO2 discharges. Additionally, during burning of coal brings about the arrival of various different poisons into climate, including, nitrogen oxides NOx, carbon monoxide CO, sulfur dioxide SO2, and particulate issue (Lopez, An et al. 2012).

Nationally, the governments of India, Nepal, Pakistan and Afghanistan have taken some steps towards tackling the harmful environmental impact of the brick kilns. India has put in place a limit on emissions depending on the size of the kilns, whilst the Ministry of Environment and Forestry also regulates the height of chimneys which has initiatives in the market based mechanism through which energy can be promoted by the instrument of fiscal in energy intensive industries (Maithel, S et al. 2012). In Pakistan, under the 1997 Environmental Protection Act (under the Ministry of Environment), anybody causing environmental pollution can be penalized and Environment Protection Orders be issued to brick kiln owners. The North West Frontier Province Environmental Protection Agency has developed Environmental Assessment Checklists & Guidelines for Brick Kiln units (2004) (Environment, Human Labour & Animal Welfare. 2017).

Zigzag brick kilns comprises of an extended terminating region that is isolated into different chambers utilizing green blocks. Most of them use a natural draft, others utilize a fan to draw the fire and warmth through the zigzag stacking design. There is need of skilled and well prepared labors for the terminating procedure to keep up the oven. The current innovation has not been institutionalized thus, there is changed execution level and emanations profile related with changing to the zigzag heating process. One block business person accomplished a 20-30% decrease in coal use subsequent to changing to the zigzag stacking process. It is additionally lessened measure of dark carbon and SPM by this diminishment carbon credits can be procure and pitch to the carbon markets (Lopez, An et al. 2012).

Involvement in other South and East Asian nations, including India, Nepal, and Vietnam, shows that the IFCK, VSBK, zigzag, and HHK are generously more clean: they consume very low energy and emanate bring down levels of conventional pollutions and CO2 discharges. Embracing these advancements would be made simpler if they were all the more socially and monetarily productive (Environment, Human Labor and Animal Welfare. 2017). Carbon financing could give the essential motivations to business visionaries to change to new technologies. Under Kyoto protocol which permits the Annex 1 developed nation through which they can buy CER from developing nation through the Clean Development Mechanism (CDM) which is one of the money related instruments. On other hand there are other money related tools, for example, "voluntary emission reduction" (VERs); for those nation who have not marked the Kyoto convention. For instance, the World Bank Community Development Carbon Fund (CDCF) is supporting Technology and Action for Rural Development (TARA) in India to spread VSBK on an extensive scale (Development Alternatives, 2005). While recognizing the generally acknowledged impediments of carbon financing, this is just a single potential technique for built up brick kiln business people to overhaul their furnace technology (Lopez, An et al. 2012). The CASE project supported by the World Bank, Development Alternatives (India) and Practical Action (Bangladesh) has launched 20 demonstration projects to facilitate far reaching selection of cleaner and proficient innovation by business people, persuaded by both the monetary and natural advantages. The venture is offering expertise and support to set up new technologies, for example, New Zigzag Kilns, Improved Zigzag Kilns (Environment, Human Labor and Animal Welfare. 2017). The investigation expect that the business visionary pays the majority of the above expenses and gets every one of the advantages connected to brick production (Environment, Human Labor and Animal Welfare. 2017).

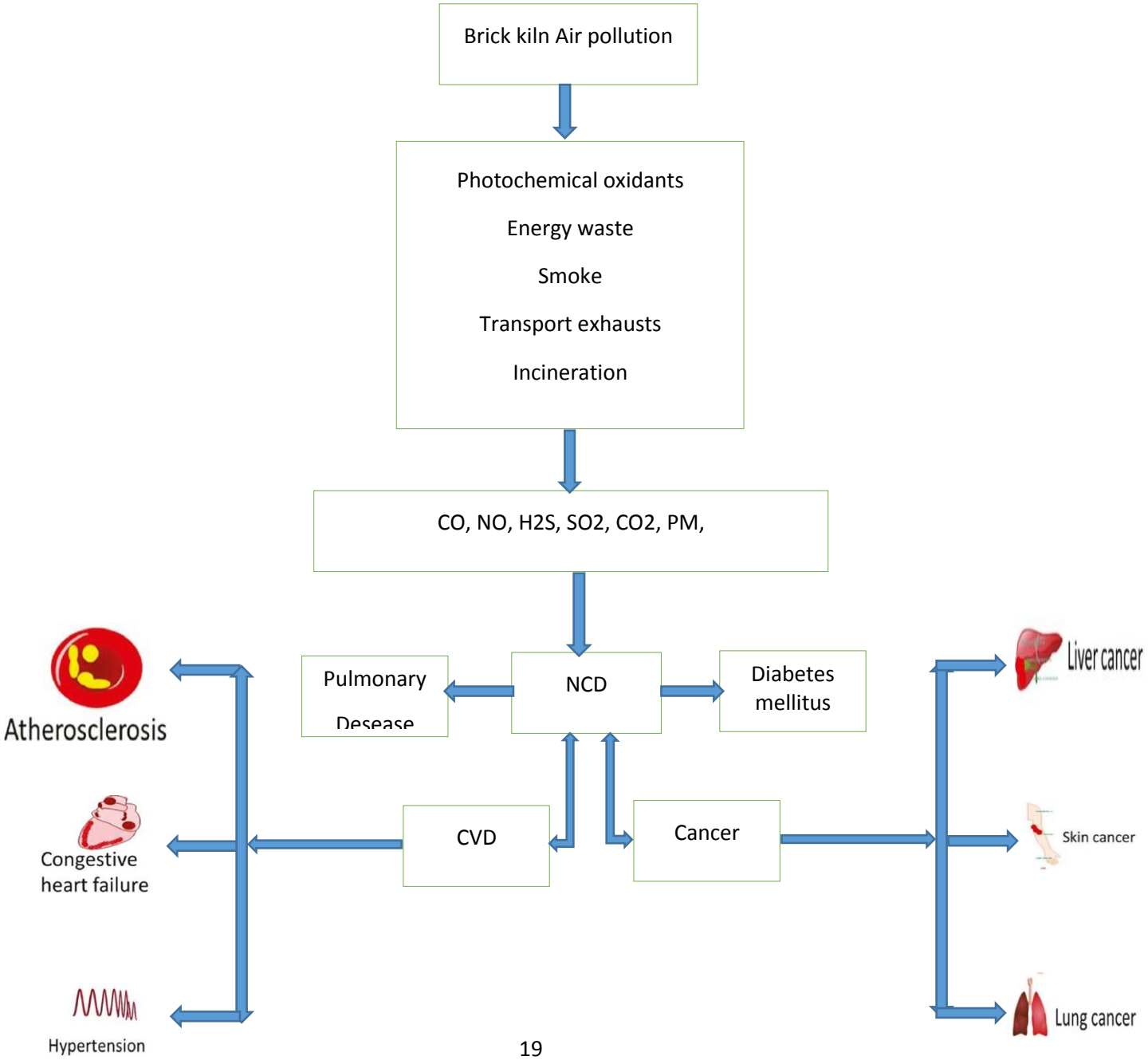
CHAPTER 3

THEORATICAL FRAMEWORK

Air contamination, a key element to environmental degradation, is too an important cause of health hazard, and its seriousness relies upon the subject's revelation either to an indoor or open air source. Our well-being is affected by out-door air pollution which consists of PM, polycyclic aromatic hydrocarbons (PAHs), nitric oxide (NO), ground-level ozone, hydrogen sulfide (H2S), sulfur oxides and carbon monoxides (CO), these are the results of energy waste, transport exhaustion and construction of buildings (Guarnieri, M. and Balmes, J.R. 2014). PAHs are known to be very harmful to human health, which damages mtDNA and can encourage carcinogenesis (Pavanello, S et al. 2013). Electric power generation, petroleum, home heating, smoke, production of black carbon, reuse incineration and coal are the key sources of PAHs (Abdel-Shafy, H.I. and Mansour, M.S. 2016). Macrophage reaction and mucociliary freedom is reduced and inflammation in bronchioles has been observed (Tecer, L.H et al. 2008). Due to the key pollutants present in household sources which contains UFPM and PM that furthers harms mitochondria (Li, R., Kou, X et al. 2015). This may prompt wheezing, respiratory contaminations, asthma assault interceded challenges and unending obstructive pneumonic illnesses.

Co, portion of gaseous air pollution, if left open to breath can lead to serious health hazards such as perinatal death, the cause of higher carboxyl hemoglobin, which further leads to reduced delivery of oxygen to vital organs (Chou, C.H et al. 2012) and ischemia aggravated by mitochondrial dysfunction (Reboul, C., Boissière, J et al. 2017). Irritation in airways can be caused due to higher concentration of nitrogen oxides and nitrogen dioxide which are emitted from agriculture and industries (Hunt, J. 2006). Increased morbidity and mortality in infants and old age people is linked with sulfur dioxide, causing respiratory illness such as bronchitis and asthma

(Wang, X.B., Du, J.B. and Cui, H. 2014). Sulfur dioxide is also a source of difficulty in breathing, heart failure, corneal haze, airway irritation, eye inflammation, pulmonary edema are a few to name. Adding another important air contamination component, PAHs, can impose long-lasting well-being issues such as cancer. (Jarvis, I.W et al. 2014), lung function abnormalities, liver damage, breathing problems, and cataracts (Rengarajan, T et al. 2015).



CHAPTER 4

DATA AND METHODOLOGY

4.1 Study Area

Lahore is cultural and industrial hub surrounded by fertile crop land. Lahore is industrial belt contains everything from brick kilns and Pharmaceutical plants which emit toxic pollutants, while millions of low fuel efficiency cars play their role to emit the CO2. While the lack of approved technology at the brick kilns has resulted in an increased amount of smog and subsequently the spread of viral diseases, worn-out tires being used as fuel to run the brick kilns and coal engines' has raised menace of air pollution to a new high. According to Pakistan today, more than 10,000 brick kilns being operated in 37 districts of Punjab including Lahore, which are adding environmental pollution on daily basis. The most of the brick kilns operate in Raiwand and near its surroundings which cause different kinds of physical diseases. The presence of large amount particulate matter is a noticeable issue all around which is a matter of worry because of genuine health issues.

4.2 Sample Size and Data Collection

Raiwand is selected from district Lahore as a study area. The area radius is 3km for both the treated and control group where zigzag brick kiln and conventional is the treated area with the radius of 3km, while non-brick kiln area has been taken as control group of the same above radius. According to Punjab Bureau of statistics, (2017) the total population of Raiwand is 8, 55,626. On the basis of population we have chosen a sample size of 150 respondents with 95% confidence level and 5% confidence interval. Survey will be conducted through Questionnaires for the estimation of health impact.

4.3 Method

(i) for the first objective we are using **IRR** and **CBA** to examine the economic feasibility of zigzag technology).

Table 4.3.1(i) Valuation methods to estimate costs and benefits

Analysis type	Costs and benefits	Valuation method
Output	**Costs:** Investment, land, buildings, operating costs, taxes **Benefits:** Value and production of bricks	Market prices

(ii) For the second objective, we have examined the impact of emission reduction due to zig zag technology on the physical health of residents in the neighborhood. This will be done by using the following equation

$$PH_{ij} = \beta_0 + \beta_1 TAij + \beta_2 AGEi + \beta_3 GENDi + \beta_4 ADi + \beta_5 EDi + \beta_6 TM\_Ej + \beta_7 HHIj + \beta_8 HHSj + \beta_9 TSj + \beta_{10} U\_SMi + \beta_{11} PSj + \mu \dots\dots\dots\dots\dots\dots 1$$

In second model, we have analyzed the impact of conventional brick kiln emissions on household's physical health.

$$PHij = \beta_0 + \beta_1 Cij + \beta_2 AGEi + \beta_3 GENDi + \beta_4 ADi + \beta_5 EDi + \beta_6 TM\_Ej + \beta_7 HHIj + \beta_8 HHSj + \beta_9 TSj + \beta_{10} U\_SMi + \beta_{11} PSj + \mu \dots\dots\dots\dots\dots\dots 2$$

Where,

PH is the physical health that is asthma, cough and other airborne disease of individual i in

area j. the frequency of the incident is also checked. This is identified through household survey.

***TA*:** It is the treatment group (or household living within the treated area). A household living within the radius of 3 kilometers by the zigzag brick kilns and conventional brick kiln are counted in the treated group and are given the value 1 while 0 for household living in control area where there is no brick kiln is situated.

***AGE*:** This shows age of the household.

***GEND*:** Household's gender; 1 for male while 0 for female. Those male who are working with in the radius have high chance to get sick because they spent more time outside and those men who are working outside the radius may have less chance to get sick as compare to female.

***AD*:** Air direction play important role if the household living where the air direction then brick kiln's smoke affect them more

***ED*:** Education is also important variable those who are more educated they use more precautions.

***TM_E*:** Family member who are employed which is also affect the health. If member employed and working outside the radius and spend more time on job are expected to have less chance to be affected.

***HHI*:** It is household member's monthly income. Those who have high income will have better environment and use precaution.

***HHS*:** Number of the family.

***TS*:** It shows how much time family spent time in brick kiln area. If they are spending more time in brick kiln area that there will be negative impact on health.

***U*_SM:** It shows whether they are using different safety measures such as mask, handkerchief. Those who are using will be given the value of 1 otherwise 0.

PS: Smoking has also significance impact on health, it is dummy variable so 1 for smoking and 0 otherwise

Chapter 5

DESCRIPTIVE STATISTICS AND RESULTS

5.1: Descriptive Statistics

Table 5.1 shows the descriptive statistics of conventional brick kiln. The average of respondents is 39 years. Further table shows that mean weight was 66 KGs. During survey it was observed that most of the respondents were uneducated and the mean education was 7 years. The average family size was 9, because most of respondents were living in a joint family system. During the survey it was also observed that the frequency of disease of those respondents was high who were living near the conventional brick kiln area.

Table 5.1: Descriptive Statistics (Conventional)

VARIABLES	N	Mean	SD	Min	Max
Age	100	39.94	16.16	12	85
Gender	100	0.360	0.482	0	1
Education	100	7.890	5.925	0	18
Weight	100	66.53	12.50	40	95
Height	100	5.530	0.418	4.100	6.500
Household Individuals	100	9.860	3.627	3	18
Marital Status	100	1.820	1.266	1	4
Working hours in Brick Kiln	100	0.110	0.314	0	1
Occupation	100	3.440	1.672	1	6
Income	100	44,620	20,411	10,000	150,000
Type of House	100	0.270	0.446	0	1
Years lived in a house	100	15.13	12.04	1.500	50
Smoking	100	0.260	0.441	0	1
Fuel for Cooking	100	1.730	0.489	0	3
Cough	100	0.550	0.500	0	1
Asthma	100	0.170	0.378	0	1
Sneezing	100	0.200	0.402	0	1
Eye Infection	100	0.200	0.402	0	1
TB	100	0.100	0.302	0	1
Skin Infection	100	0.110	0.314	0	1

Table 5.2 shows the descriptive statistics of Zig-Zag brick kiln which shows the different aspects of demographic variables as compared to the conventional brick kilns. In this table the mean age is 34 years, while the mean education is 9 years which is relatively high from conventional brick kiln area. Like education the mean height of respondents of Zig Zag brick kiln is slightly higher than the respondents of conventional brick kilns. This table shows that the frequency of diseases is lower than the frequency of diseases occurring in conventional brick kiln are, but it was also observed that the frequency of asthma was higher in respondents living near Zig Zag brick kiln which is unusual, but in our results we couldn't capture the reason occurring behind it.

Table 5.2: Descriptive Statistics (Zigzag)

VARIABLES	N	Mean	SD	Min	Max
Age	100	34.97	13.47	10	72
Gender	100	0.280	0.451	0	1
Education	100	9.630	4.933	0	18
Weight	100	66.63	11.55	40	95
Height	100	6.110	5.148	4.500	5.7
Household Individuals	100	7.980	3.303	2	18
Marital Status	100	1.730	1.262	1	4
Working hours in Brick Kiln	100	0.120	0.327	0	1
Occupation	100	2.980	1.341	1	5
Income	100	37,900	20,131	18,000	150,000
Type of House	100	0.260	0.441	0	1
Years lived in a house	100	10.31	10.23	2	50
Smoking	100	0.250	0.435	0	1
Fuel for Cooking	100	1.880	0.383	0	3
Cough	100	0.480	0.502	0	1
Asthma	100	0.0700	0.256	0	1
Sneezing	100	0.100	0.302	0	1
Eye Infection	100	0.150	0.359	0	1
TB	100	0.0300	0.171	0	1
Skin Infection	100	0.0300	0.171	0	1

The table 5.3 shows the probability of disease in conventional brick kiln as compare to the non-brick kiln area. In this table the probability of occurring of eye infection for people living in conventional brick kiln area is 9.5% higher than the people living in non-brick kiln area. The probability of skin infection occurring in people living nearby conventional brick kiln is 15.3% higher than people living in non-brick kiln area. Whereas cough, asthma, sneezing and TB have statistically insignificant impact of conventional brick kiln on the probability of diseases.

Table 5.3: Impact of Conventional Brick Kiln on Probability of Disease

VARIABLES	(1) Cough	(2) Asthma	(3) Sneezing	(4) Eye Inf.	(5) TB	(6) Skin Inf.
Conventional Brick Kiln	0.013	0.086	0.028	0.095*	0.027	0.153**
	(0.034)	(0.017)	(0.023)	(0.013)	(0.005)	(0.009)
Constant	0.202	0.155	-0.455**	-1.021	0.729	1.318
	(0.850)	(0.616)	(0.025)	(1.094)	(0.805)	(0.214)
Observations	100	100	100	100	100	100
R-squared	0.393	0.371	0.255	0.411	0.316	0.335
Individual Char.	YES	YES	YES	YES	YES	YES
Household Char. FE	YES	YES	YES	YES	YES	YES

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1: The controls included age, gender, education, education, marital status, weight, height, household size, household income, type of house, number of years lived in this house, whether the individual works at the brick kiln, whether the individual smokes, and type of fuel used for cooking in the house.

Table 5.4 shows the frequencies in incidence of diseases in area where there is conventional brick kiln, as the table 5.3 shows the probability of diseases, this table shows the further frequency of those diseases and chances that how many times the respondents have the chances to fall sick. The table shows that cough, eye infection and skin infection are statistically significant so the chances of having cough frequently are 38.2%, while eye infection has chances to occur 6.6% and skin infection has probability of occurring 22.7%. Whereas asthma, sneezing and TB are statistically insignificant in nearby conventional brick kiln.

Table 5.4: Impact of Conventional Brick Kiln on Frequency of Disease

VARIABLES	(1) Cough	(2) Asthma	(3) Sneezing	(4) Eye Inf.	(5) TB	(6) Skin Inf.
Conventional Brick Kiln	0.382*	0.068	0.218	0.066**	0.027	0.227*
	(0.032)	(0.020)	(0.061)	(0.003)	(0.005)	(0.021)
Constant	-1.558	-0.049	-1.309	-0.923	0.729	1.836
	(4.198)	(0.067)	(1.844)	(1.609)	(0.805)	(0.486)
Observations	98	99	99	100	100	100
R-squared	0.542	0.204	0.277	0.358	0.316	0.252
Individual Char.	YES	YES	YES	YES	YES	YES
Household Char. FE	YES	YES	YES	YES	YES	YES

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1: The controls included age, gender, education, education, marital status, weight, height, household size, household income, type of house, number of years lived in this house, whether the individual works at the brick kiln, whether the individual smokes, and type of fuel used for cooking in the house.

Table 5.5 shows the probability of disease of respondents nearby zigzag brick kiln as compare to non-brick kiln. In this table asthma and TB are statistically significant while TB is statistically has negative sign. The probability of having asthma is 6.6% higher as compared to the places where there is no Brick kiln, whereas the probability of having TB is 3.5% lower as compared to the non-brick kiln area, which is unusual and our observations couldn't capture the cause behind this result. While cough, sneezing, eye infection and skin infection are statistically insignificant impact of zigzag brick kiln on probability of disease and there is negative sign in sneezing which means probability of having sneezing is lower than the non-brick kiln area.

Table 5.5: Impact of Zigzag Brick Kiln on Probability of Disease

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Cough	Asthma	Sneezing	Eye Inf.	TB	Skin Inf.
Zig-Zag Brick Kiln	0.067	0.066**	-0.186	0.019	-0.035***	0.015
	(0.046)	(0.004)	(0.036)	(0.071)	(0.000)	(0.027)
Constant	-0.872	0.024	-0.434	0.625	0.181	0.149
	(0.829)	(0.468)	(0.578)	(0.354)	(0.306)	(0.158)
Observations	100	100	100	100	100	100
R-squared	0.348	0.417	0.390	0.295	0.311	0.095
Individual Char.	YES	YES	YES	YES	YES	YES
Household Char. FE	YES	YES	YES	YES	YES	YES

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1: The controls included age, gender, education, education, marital status, weight, height, household size, household income, type of house, number of years lived in this house, whether the individual works at the brick kiln, whether the individual smokes, and type of fuel used for cooking in the house.

Table 5.6 shows the frequencies in incidence of diseases in area where there is Zig-Zag brick kiln. This table shows the how many times a respondents can be sick those respondents who are living nearby zigzag brick kiln. Further table shows that sneezing and TB are statistically significant whereas cough, asthma, eye infection and skin disease are statistically insignificant. Whereas the negative sign of coefficient with cough, asthma, sneezing, and TB are those disease whose frequency of occurring is decreasing. Further table shows that the chances of having sneezing are 19%, while chances of occurring TB is decreased by 3.5% as we mentioned in above table that it is unusual and we were unable to capture the reason behind it.

Table 5.6: Impact of Conventional Brick Kiln on Frequency of Disease

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Cough	Asthma	Sneezing	Eye Inf.	TB	Skin Inf.
Zigzag	-0.844	-0.036	-0.190*	0.010	-0.035***	0.015
	(0.204)	(0.084)	(0.020)	(0.072)	(0.000)	(0.027)
Constant	0.744	-0.375	-0.640	0.651	0.181	0.149
	(1.333)	(0.946)	(0.476)	(0.231)	(0.306)	(0.158)
Observations	98	99	99	99	100	100
R-squared	0.302	0.284	0.506	0.293	0.311	0.095
Individual Char.	YES	YES	YES	YES	YES	YES
Household Char. FE	YES	YES	YES	YES	YES	YES

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1: The controls included age, gender, education, education, marital status, weight, height, household size, household income, type of house, number of years lived in this house, whether the individual works at the brick kiln, whether the individual smokes, and type of fuel used for cooking in the house.

Cost benefit Analysis:

The average cost of capital machine is 2,500,000 for the first time. The average machine life is 12 years estimated. The operational and maintenance cost of this technology is 5 lac every 2 years. The discounted rate we have used is 8.75% (SBP. 2018). The market price of 1 brick is 7 RS and the production of bricks in 1 season is 10,000,000.

Table 5.7: Cost Benefit Analysis of Zig-Zag brick kiln

Years	Initial Outlay	Inflow	Maintenance Cost	Net Inflow	Discount Factor (KIBOR) Bid Rate - 3 yrs 8.75%	**PV of Investment**
YEAR 0	(2,500,000)		-	(2,500,000)	1.0000	**(2,500,000)**
YEAR 1	-	70,000,000	-	70,000,000	0.9195	**64,365,000**
YEAR 2	-	70,000,000	(500,000)	69,500,000	0.8455	**58,762,250**
YEAR 3	-	70,000,000	-	70,000,000	0.7775	**54,425,000**
YEAR 4	-	70,000,000	(500,000)	69,500,000	0.7149	**49,685,550**
YEAR 5	-	70,000,000	-	70,000,000	0.6574	**46,018,000**
YEAR 6	-	70,000,000	(500,000)	69,500,000	0.6045	**42,012,750**
YEAR 7	-	70,000,000	-	70,000,000	0.5558	**38,906,000**
YEAR 8	-	70,000,000	(500,000)	69,500,000	0.51117	**35,526,315**
YEAR 9	-	70,000,000	-	70,000,000	0.4700	**32,900,000**

YEAR 10	-	70,000,000	(500,000)	69,500,000	0.4322	**30,037,900**
YEAR 11	-	70,000,000	-	70,000,000	0.3974	**27,818,000**
YEAR 12	-	70,000,000	(500,000)	69,500,000	0.3654	**25,395,300**
Total	**(2,500,000)**	**840,000,000**	**(3,000,000)**	**834,500,000**		**503,352,065**

The table 5.7 shows the positive cash inflow of this technology, as per cost benefit analysis if we use machine for 12 years there will be net flow of PKR 834,00000,000. As we calculated the present value of the project, based on KIBOR of august 2018 at bid rate of 3 years we will get a positive net present value of PKR 503,352,065. Based on above calculation the project is recommended for the investment as we have healthy positive inflow from the project.

Chapter 6

CONCLUSION AND RECOMMENDATIONS

6.1: Conclusion:

Conventional brick kiln is one of the major source of air pollution which impacts the environment and human health. It is concluded that the people living around the conventional brick kilns are more prone to diseases than the people living in non-brick kiln and Zig-Zag brick kiln area. This study has differentiated the health status of non-brick kiln, conventional, and Zig-Zag households, further this study has uncovered the health status of nearby individuals of conventional brick kiln which shows that the household living near this old technology has high frequency of disease as compared to non-brick kiln and Zig-Zag technology.

In view of occasional profitability, obsolete technology, low efficiency of work, non-existent capitalization and casual administration framework the brick making industry in Pakistan is depicted as "footloose" industry. Despite the fact that the conventional brick kiln is the reason behind the polluted environment; the vast majority of the brick producers or business people incline toward it for its low capital necessity and exceptional yields and additionally easy installation.

Cost benefit analysis results shows the that there is positive cash inflow of zigzag technology, further results shows that if we use machine for 12 years there will be beneficial net flow which is shown in (Table 5.7). The project is highly recommended for the investment based on our calculation which shows positive inflow from the from the zig-zag brick kiln. As a single unit conventional brick kiln needs just PKR. 1.4 million, speculations while zig-zag costs is at least

PKR. 2.5 million. Individuals won't be effectively persuaded to grow another brick kiln. They are generally unfit to manage the cost of them and will result in an expansion in cost of brick.

6.2: Recommendations

Government need to push individuals by providing awareness against conventional brick kilns and make the Zig-Zag essentially accessible to the brick makers. Zig Zag brick kilns reduces the risk of harming air pollution by less consumption of coal which in longer run results in less diseases and health cost. Electronic and print media should approach to support individuals for utilizing such sorts of bricks. Additional promoting is required to acquaint individuals with green brick. To support business individuals, banks need to give long haul credit. However, the issue is in accepting credit from banks, a business visionary needs to finish countless including confirmation of authentications furthermore, licenses. The government should also introduce subsidies and incentive to encourage brick kiln owners to shift from conventional to Zig-Zag technology as it is in the less environmentally polluting as well as proven more efficient in brick making. The government can later generate carbon credits from the cut down of carbon pollutants. Carbon credits can be sold in the international market to give benefit to the owners who has shifted from conventional to this new cleaner technology which can encourage other brick owners to the same. More and more trainings and awareness is required to shift from one to another technology as the brick that has shifted from conventional to Zig-Zag still cannot work efficiently as much as it is expected to be as the owners are introduced new to this technology and needs more trainings and workshops to fully understand how can be this technology can be put to get maximum benefit out of it.

REFRENCES:

A. B. Ghosh, J. C. Bajaj, R. Hassan, and D. Singh, Laboratory Manual for Soil and Water Testing 1st Edition, Soil Testing Laboratory, Division of Soil Science and Agricultural Chemistry, IARI,New delhi, India, 1983

Abdel-Shafy, H.I. and Mansour, M.S., 2016. A review on polycyclic aromatic hydrocarbons: source, environmental impact, effect on human health and remediation. Egyptian Journal of Petroleum, 25(1), pp.107-123.

Akinshipe, O. and Kornelius, G., 2017. Chemical and Thermodynamic Processes in Clay Brick Firing Technologies and Associated Atmospheric Emissions Metrics-A Review. J Pollut Eff Cont, 5(190), p.2.

Alam S A and Starr M. (2009) 'Deforestation and greenhouse gas emissions associated with fuel Wood consumption of the brick making industry in Sudan Science of The Total Environment, Vol.407, pp. 847 – 852

Baron, Robert E. W, et al., 2009. "An Analysis of Black Carbon Mitigation as a Response to Climate Change." Copenhagen Consensus Center.

Baum, Ellen. 2010. "Black Carbon from Brick Kilns." Paper presented to the Clean Air Taskforce, April 7.

Boschetto P, Quintavalle S, Miotto D, Lo-Cascio N, Zeni E, Mapp CE (2006). Chronic obstructive pulmonary disease and Occupational exposures. J. Med. Toxicol. 1:11.

Chou, C.H., Lai, C.H., Liou, S.H. and Loh, C.H., 2012. Carbon monoxide: An old poison with a new way of poisoning. Journal of the Formosan Medical Association, 111(8), pp.452-455.

Chow, J. C., Watson, J. G., Chen, L. W. A., Arnott, W. P., Moosmüller, H., and Fung, K.: Equivalence of elemental carbon by thermal/optical reflectance and transmittance with Different temperature protocols. Environ. Sci. Technol., 38 (16), 4414- 4422, 2004.

Croitoru, L. and Sarraf, M., 2012. Benefits and costs of the informal sector: the case of brick kilns in Bangladesh. Journal of Environmental Protection, 3(06), p.476.

Das, R., 2015. Socio-Economic Conditions of Female Workers in Brick Kilns-An Exploitation to Healthy Social Structure: A Case Study on Khejuri CD Blocks in Purba Medinipur, West Bengal. Internation Journal of Science & Research, 4(1) a.

Das, R., 2015. Work related Injuries and Musculoskeletal Disorders among Child Workers in the Brick Kilns of Khejuri of Purba Mediipur in West Bengal. International Journal, 3(3) b.

Das, S., Hasan, M.S.Q., Akhter, R., Huque, S., Khandaker, S., Gorapi, M.Z.H. and Shahriar, M., 2017. Socioeconomic conditions and health hazards of brick field workers: A case study of Mymensingh brick industrial area of Bangladesh. Journal of Public Health and Epidemiology, 9(7), pp.198-205.

Development Alternatives. 2005. “A Guidance Document for Entrepreneurs and Project Auditors.

Environment, Human Labour & Animal Welfare Unveiling the full picture of South Asia’s brick kiln industry and building the blocks for change 2017.

Erbe and S. Oliver, “Technical, economical and organizational analysis of informal brick production in Tercera Chica,” Doctoral Diss., Cologne University of Applied Sciences, México, SLP, 2011.

Fidan F, Unlu M, Koken T, Tetik L, Akoun S, Demrel R, Serteser M (2005). Oxidant-anti oxidant status and pulmonary function in welding workers. J. Occup. Health 47:286-292.

Gordon S B , Curran A D , Fishwick D , Morice A H and Howard P. (1998) ‘Respiratory Symptoms among glass bottle workers — cough and airways irritancy syndrome Occup. Med. Vol. 48, No. 7, pp. 455-459

Guarnieri, M. and Balmes, J.R., 2014. Outdoor air pollution and asthma. The Lancet, 383(9928), pp.1581-1592.

Gupta, J. (2003), “Informal labour in brick kilns. Need for regulation”, Economic and Political Weekly, pp. 3282- 92, August

Heierli, Urs, and Maithel, Sameer. 2008. “Brick by Brick: The Herculean Task of Cleaning of the Asian Brick Industry.

Hunt, J., 2006. Airway acidification: interactions with nitrogen oxides and airway inflammation. Current allergy and asthma reports, 6(1), pp.47-52.

Imran MA, Baten MA, Nahar BS, Morshed N. Carbon dioxide emission from brickfields around Bangladesh. International Journal of Agricultural Research, Innovation and Technology. 2015 Mar 20;4(2):70-5.

International Journal of Applied Research 2015; 1(9): 95-99 Palash Patra

International Union Soil Science (IUSS). 2002. Soil and the environment, IUSS Commission VIII. World Cong of Soil Science, International Union Soil Science, Thailand, p. 66

Iqbal, M., 2016. Financial feasibility of environment friendly brick manufacturing in the context of Bangladesh.

Jarvis, I.W., Dreij, K., Mattsson, Å., Jernström, B. and Stenius, U., 2014. Interactions between polycyclic aromatic hydrocarbons in complex mixtures and implications for cancer risk assessment. Toxicology, 321, pp.27-39.

Joshi, S. K., & Dudani, I. (2008). Environmental Health Effects of Brick Kilns in Kathmandu Valley. Kathmandu University Medical Journal, Vol.6. Is. 21. Pp.3-11.

Kainth, G.S., 2009. Push and pull factors of migration: a case of brick kiln industry of Punjab State. Asia-Pacific Journal of Social Sciences, 1(1), pp.82-116.

Kenney WL. A review of comparative responses of men and women to heat stress. Environ Res 1985; 37: 111. 1

Li, R., Kou, X., Geng, H., Xie, J., Yang, Z., Zhang, Y., Cai, Z. and Dong, C., 2015. Effect of ambient PM2. 5 on lung mitochondrial damage and fusion/fission gene expression in rats. Chemical research in toxicology, 28(3), pp.408-418.

Lin, J.C.M., 2006. Development of a high yield and low cycle time biomass char production system. Fuel processing technology, 87(6), pp.487-495.

Lopez, A., Lyoda, N., Segal, R. and Tsai, T., 2012. Building materials: Pathways to efficiency in the South Asia brickmaking industry. The Carbon War Room, school of advanced International studies, Johns Hopkins University.

M. F. Jerin et al. 2016. Impacts of Brick Fields on Environment and Social Economy at Bagatipara, Natore, Bangladesh. . Environ. Sci. & Natural Resources, 9(2):31-34, 2016. ISSN 1999-7361.

M. Sameer et al., Energy Conservation and Pollution Control in Brick Kilns, Tata Energy Research Institute, Habitat Place, New Delhi, India,1999.

Maithel, S., Uma, R., Bond, T., Baum, E., & Thao, V. T. K. (2012). Brick kilns performance assessment, emissions measurements, & a roadmap for cleaner brick production in India. Study report prepared by Green Knowledge Solutions, New Delhi.; and CCAC (2014). Factsheets about Brick Kilns in South and South-East Asia.

Maithel, S., Uma, R., Kumar, A. and Vasudevan, N., 1999. Energy conservation and pollution control in brick kilns. Tata Energy Research Institute, Habitat Place, New Delhi, India.

Martínez-Salinas, R. I., Elena Leal, M., Batres-Esquivel, L. E., Domínguez-Cortinas, G., Calderón, J., Díaz-Barriga, F., and Pérez-Maldonado, I. N.: Exposure of children to polycyclic aromatic hydrocarbons in Mexico: assessment of multiple sources. 25 Int Arch Occup Environ Health, 83: 617, doi: s00420-009-0482-x, 2010.

Michaelowa, A. and Umamaheswaran, K., 2006. Additionality and Sustainable Development Issues regarding CDM projects in energy efficiency Sector.

Molina, L.T., Zavala, M., Maiz, P., Monsivais, I., Chow, J. and Munguia, J., 2013, December. Black Carbon And Co-Pollutants Emissions And Energy Efficiency From Bricks Production In Guanajuato, Mexico. In AGU Fall Meeting Abstracts.

Mukhopadhyay P. Risk factors in manual brick manufacturing in India. HFESA J Ergon Aus 2008; 22: 625.

Parsons KC. Human thermal environments: the effects of hot, moderate and cold environments on human health, comfort and performance. Vol. 22. London: Taylor and Francis; 2003, pp. 4260.

Pavanello, S., Dioni, L., Hoxha, M., Fedeli, U., Mielzynska-Švach, D. and Baccarelli, A.A., 2013. Mitochondrial DNA copy number and exposure to polycyclic aromatic hydrocarbons. Cancer Epidemiology and Prevention Biomarkers, 22(10), pp.1722-1729.

R. Linda and M. R. Culler, "Clinical occupational medicine," Journal of Occupational and Environmental Medicine, vol. 28, no. 11, pp. 1138-1140, 1986.

Rana, M. and Das, A., 2014. Causes and Consequences of Child work in Brick Field: A Study on the Selected Brick Fields in Char Bhadrasan under Faridpur District. IOSR Journal of Business and Management.

Raut, A. K. (2003). Brick Kilns in Kathmandu Valley: Current status, environmental impacts and future options. Himalayan Journal of Science, Vol. 1. Is. 1. Pp. 59-61.

Reboul, C., Boissière, J., André, L., Meyer, G., Bideaux, P., Fouret, G., Feillet-Coudray, C., Obert, P., Lacampagne, A., Thireau, J. and Cazorla, O., 2017. Carbon monoxide pollution aggravates ischemic heart failure through oxidative stress pathway. Scientific reports, 7, p.39715.

Rengarajan, T., Rajendran, P., Nandakumar, N., Lokeshkumar, B., Rajendran, P. and Nishigaki, I., 2015. Exposure to polycyclic aromatic hydrocarbons with special focus on cancer. Asian Pacific Journal of Tropical Biomedicine, 5(3), pp.182-189.

Rizwana Khan & Harish Vyas. 2008. A STUDY OF IMPACT OF BRICK INDUSTRIES ON ENVIRONMENTAND HUMAN HEALTH IN UJJAIN CITY. Journal of Environmental Research and Development Vol. 2 No. 3

Rogaly, B., Biswas, J., Coppard, D., Rafique, A., Rana, K.and Sengupta, A. (2001), "Seasonal migration, social change and migrant's rights. Lessons from West Bengal", Economic and Political Weekly, pp. 4547- 59, December 8

Sahu S, Sett M, Gangopadhyay S. An ergonomic study on teenage girls working in the manual brick manufacturing units in the unorganized sectors in West Bengal, India. J Hum Ergol 2010; 39: 2333.

Saiyed HN, Tiwari RR. Occupational health research in India. Ind Health 2004; 42: 1418. 6

Sharma D.K., Varun A. and Patel M., 2013. QUALITATIVE STUDY ON CLINICO-SOCIAL PROBLEMS OF BRICK-KILN WORKERS: A STUDY FROM ANAND, GUJARAT. National Journal of Community Medicine, 4(3).

Shewale A., Acharya S., Shinde R.R., 2013. Nutritional and morbidity profile of brick kiln workers in Sakwar, Tribal area of Thane District. Medical Journal of Western India, 41(1).

Spies A and Naicker N. (2006) 'Pilot study to determine the extent and nature of occupational exposure to airborne pollutants associated with clay mining and brick-making National Institute for occupational Health, January 2006

Suman Kumar Pariyar, Tapash Das. 2013. Environment And Health Impact For Brick Kilns In Kathmandu Valley, INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 2, ISSUE 5

T. J. Woodruff et al., "Disparities in exposure to air pollution during pregnancy," Environmental Health Perspectives, vol. 111, no. 7, pp. 942, 2003.

Tecer, L.H., Alagha, O., Karaca, F., Tuncel, G. and Eldes, N., 2008. Particulate matter (PM2. 5, PM10-2.5, and PM10) and children's hospital admissions for asthma and respiratory diseases: A bidirectional case-crossover study. Journal of Toxicology and Environmental Health, Part A, 71(8), pp.512-520.

Wang X. (2010) 'Environmental Pollution from Rural Brick-making Operations and Their Health Effects on Workers -Research Design Northwestern University for Nationalities West Of China Institute of Environmental Health

Wang, X.B., Du, J.B. and Cui, H., 2014. Sulfur dioxide, a double-faced molecule in mammals. Life sciences, 98(2), pp.63-67.

Zusman, E., Miyatsuka, A., Evarts, D., Oanh, N.K., Klimont, Z., Amann, M., Suzuki, K., Mohammad, A., Akimoto, H., Romero, J. and Hannan Khan, S.M., 2013. Co-benefits: taking a multidisciplinary approach. Carbon Management, 4(2), pp.135-137.

Appendix:

Questionnaire

Section I: Personal Information

1. Age: _____
2. Gender:
    1. Male
    2. Female
3. Education level _____

    1. Never went to school 2. Primary 3. Middle 4. Matric
    5. Intermediate 6. BSc 7. MSc 8. Any other _____
4. Weight? _____kg
5. Height? _____ cm
6. Household size: _____
7. No of dependent: _____
8. Marital Status
    1. Married 3. Divorced
    2. Unmarried 4. Single
9. Do you work in Brick Kiln?

    1) Yes 2) No

10. If yes for how many hours do you work in the Brick Kiln? _____
11. If no what is your occupation?

    1) Government Job 2) Private Job 3) Daily wager 4) Own Business
    5) Any other_____
12. How far your occupation place is from brick kiln (Distance in KM)_____
13. No of employed in household? _____
14. Average monthly income of the total household? _____

Section II: Location and Air Quality

15. What type of house do you live in?

    1) Own house 2) Rented house (If own house, move to Q.16)

16. If rented, how much rent do you pay every month? _____

17. For how long you are being living in this house? (years) _____

18. Is the air quality good in your area?

    1) Yes 2) No

19. If no, then what do you think are the main causes of bad air quality in your area?

    1) Emission of brick kilns 2) Road dust 3) Vehicle emissions 4) All of the above

20. Do you live near the main road?

    1) Yes 2) No

21. If yes, what is the approximate distance between your house and the main road (meters)? _____

22. What is the approximate distance between your house and brick kiln (km)? _____

23. Are you aware that brick kiln emission causes illness?

    1) Yes 2) No

24. Do you use any safety measures while going outside?

    1) Yes 2) No

25. If yes, what type of safety measures?

    1) Mask 2) Glasses 3) Handkerchief 4) Other

26. Do you have smoking habit?

    1) Yes 2) No

27. For cooking, what type of fuel is used in your house?

    1) Wood 2) LPG 3) Kerosene

28. Have you experienced any of the following disease in the last 1year?

S.No	Name of disease	Yes/No	Number of times	Cost Incurred	Leave Taken
1	Cough				
2	Asthma				
3	Sneezing				
4	Eye Infection				
5	TB				
6	Skin Disease				

Section III: Health costs incurred

29. (For hospital treatment) doctor fee paid: _____ rupees per trip.
30. Medicinal expenditures: _____ rupees per trip.
31. Lab test expenditures: _____ rupees per trip.
32. Travelling expenses: _____ rupees per trip.
33. Loss of working hours multiplied with average wage: _____ rupees per trip.
34. Total expenditures on health deducted from total monthly income: _____ rupees per trip.