COST ANALYSIS OF AIR POLLUTANTS ON HUMAN HEALTH IN AGRA

AN

ABSTRACT

SUBMITTED FOR THE AWARD OF

DOCTOR OF PHILOSOPHY

IN ACCOUNTANCY AND LAW (COMMERCE)

Supervisor:
Dr. Pravin Saxena
Associate Professor
Department of Accountancy & Law

Researcher:
Nitin Kishore Saxena
Research Scholar
Department of Accountancy & Law

FACULTY OF COMMERCE
DAYALBAGH EDUCATIONAL INSTITUTE
(DEEMED UNIVERSITY), DAYALBAGH, AGRA
MARCH - 2012
ABSTRACT

Air pollution is a serious environmental concerns all around the globe. Over the last few decades, the intensified process of industrialization and urbanization, coupled with rapid population growth has resulted in sever environmental degradation. In particular, harmful pollutants such as Sulphur Dioxide (SO$_2$), Nitrogen Dioxide (NO$_2$), Ozone(0$_3$), Total Suspended Particles Matter (TSPM) etc, are emitted and these pollutants even exceed air quality guidelines recommended by the World Health Organization (WHO, 2005). Particulate and gaseous emissions of pollutants from industries and auto exhaust are responsible for rising discomfort, increasing airborne diseases, decreasing productivity and deterioration of artistic and cultural patrimony urban center.

Exposure to poor air quality posses serious health related problems such as respiratory symptoms or illness impaired cardiopulmonary function, reduction of lung function, and premature mortality. Research in the past decades confirms that outdoor air pollution contributes to morbidity and mortality. The poor air quality also contributes to tremendous economic losses, especially in the sense of financial resources that are required for providing medical assistance to the affected people.

India is not an exception, where majority of the population is exposed to poor air quality. India faces the similar challenges of both strengthening its economy and protecting its environment. Air quality has deteriorated in large cities in India. The major sources of air pollution include road dust re-suspension, diesel combustion, construction activities, biomass burning, certain contribution from gasoline which has polluted cities like Delhi, Mumbai, Kolkata, Chennai, Ankleshwar, Dhanbad, Howrah, Jharia, Surat, Jamshedpur, Sindri, Pune, Agra, Noida, Kanpur, Faridabad, Firozabad, Ghaziabad, etc.
Few studies establishes the linkages between air pollution and health status of human being. The global literature available in the area of air pollution and health economics has generally dealt with the western world. However, in this field there is no much work carried out for the major cities of India. With the growing peril of air pollution in India there is serious threat to the health of Indian citizens. Hence it was utmost important to understand, examine, and analyses the linkage between air pollutants and health status in India with special reference to Agra city. Therefore the topic entitled “Cost Analysis of Air Pollutants on Human Health in Agra” was taken into consideration for the purpose of proposed research.

The study mainly focuses to analyze the seasonal trends of various pollutants, assessment of air quality and to determine the various consequences of illness caused due to air pollution. It also measures the cost of illness and an attempt has been made for willingness to pay. For this purpose four major air pollutants namely Sulfur Dioxide (SO$_2$), Nitrogen Dioxide (NO$_2$), Particulate Matter (PM$_{10}$) and Total Suspended Particulate Matter (TSPM) has been taken into consideration. The study is related for the period of five years (from 2006 to 10). The respondents were from the Agra city. A questionnaire was developed to collect the primary data. The questionnaire were served to the patient who visited the OPD cell at Sarojani Naidu Medical College, District Hospital and Saran Ashram Hospital of Agra city. The data related to the above pollutants for the period under study was collected from Central Pollution Control Board (CPCB), Agra. Information was also collected from various medical stores and laboratories of Agra. The Development Officer of General Insurance Company (GIC) were also consulted to collect the Information.

In order to have a current knowledge on the subject and contribution made by various researchers and academician, a review of the available literature in this field was carried out. In this regard thirty one reviews were collected. Out of these thirty one studies, nine studies were national and rest twenty two studies were international. National studies focused on cost of illness caused by various diseases and only two study examined air pollution effect and economic loss while only a single study measured willingness to pay to avoid the risk. All the international studies talked about the effect of air pollution on human health and its economic
burden. Willingness to pay using various approaches were also examined by various researchers.

The level of selected pollutants have been compared with National Ambient Air Quality (NAAQ) standards. The level of SO$_2$ in Agra city has always been far below the NAAQ standard throughout the study period ranging between 3.73 to 9.75 µg m$^{-3}$ level. The level of NO$_2$ during the period of study has been fluctuating and ranges between 8.98 to 36.50 µg m$^{-3}$. NO$_2$ level in Agra exceeds the NAAQ standards level in the year 2008 to 2010. The increase in the level of NO$_2$ may be contributed to the fact of increase in vehicular pollution associated with an increase in vehicular traffic.

As regard to PM$_{10}$, the level has always been far above the NAAQ standard. PM$_{10}$ level has never been ever below the NAAQ standard. It ranges from 67.6 to 366.80µg m$^{-3}$. Similarly the level of TSPM in Agra has been observed to be high above the NAAQ standard. It ranges between 158.00 to 662.40 µg m$^{-3}$. The high level of both PM$_{10}$ and TSPM are probably due to suspended soil particles apart from anthropogenic aerosols. High level of TSPM and PM$_{10}$ can be attributed to additional contribution from Desert storms which are frequent in the summer month.

The level of SO$_2$ at all the sites has been within the limit of NAAQ standard. However among the sites, the level of SO$_2$ was recorded to be least at the Dayalbagh site with the mean value of 5 µg m$^{-3}$ throughout the study period. The reason for SO$_2$ being least at this site is because of it being a lush green area with tall trees and agriculture fields with no industry established in the vicinity of the site.

The Nunhai and Itmadullah sites recorded a high level of NO$_2$. The level of PM$_{10}$ at all the sites was above the NAAQ standard. The reason for high level of PM$_{10}$ may be due to the fact that these areas are undeveloped, lack of paved paths, sandy & agriculture area are the characteristic of these sites.

The level of TSPM at Dayalbagh could not be recorded due to non-availability of sampler. The level of TSPM at four sites have been always above the NAAQ standard. The highest level of TSPM recorded at Nunhai followed by Rambagh. Industrial emission, emission from diesel
generator that's operate during the failure of power and sites being closely situated near to NH-2 has led to TSPM level high at Rambagh & Nunhai.

The seasonal variation shows that TSPM is highest in summer followed by winter and monsoon. The high value in summer is contributed mainly due to soil erosion by wind and unstable atmospheric conditions. PM10 is recorded highest in winter followed by summer and monsoon. The high value of PM10 in winter was due to increase in use of biomass, fossil fuels for heating purposes. The other probable reason may be calm atmospheric condition and low level of boundary layers. SO2 does not show significant variation but values are highest in winter and lowest in monsoon. NO2 level is highest in winter followed by summer and monsoon. This may be due to increase in use of fuels for heating and lighting purposes.

**AIR QUALITY ASSESSMENT**

The air quality assessment is expressed in terms of low, moderate, high and critical for the sites. The Exceedence Factor (EF) was calculated as with the use of following formula:

\[ \text{Exceedence Factor} = \frac{\text{Observed annual mean concentration of a criterion pollutant}}{\text{Annual standard for the respective pollutant and area class}} \]

The exceedence level of SO2, varied from 0.2 to 0.5 throughout the study period, which is not as much as harmful from health point of view. The level of NO2 varies from 0.2 to 1.2 with the large variation in the exceedence level. The level of PM10 and TSPM was always higher from the standard values. PM10 value ranged from 1.2 to 6 times from the standard values whereas TSPM value from 3 to 11 times for the NAAQ standard.

In order to examine the health effect of the pollutants in the Agra city and to determine its economic cost a self constructed questionnaire was served to the various patients visiting the two major hospitals during the period under study. Responses of 3000 patients have been
taken into consideration which has formed the basis of analysis of this study and to draw the findings.

In the sample size 68.4% of the patients were male and 31.6% patients were female. The average age of males was higher as compared to females.

The patients were classified into four age groups as 10 to 25, 26 to 45, 46 to 60 and 60 and above. Among the male the highest number of patient were identified in the age group of 26-45 and similar was in the case of females. The next to follow were the patients in the age group of 10-25 for both male and females. However in the age group of 46-60 there was a significant difference among the number of patients affected due to pollution in the category of males and females. In this category 87.5% were males and 12.5% were female.

The impact of the selected pollutants namely SO$_2$, NO$_2$, PM$_{10}$ and TSPM on various diseases has been classified for the purpose of study under three broad categories - Cold and ENT Infection (CEI), Respiratory and Bronchitis (RB) and Allergic and Infection (AI). In order to assess the monetary burden of the illnesses, the COI approach has been adopted which is based on accounting of cost. The COI approach measures both direct and indirect cost of illness. The direct cost represents direct medical cost and direct non medical cost.

Direct medical cost includes expenditure incurred on consultancy, treatment, diagnosis, laboratory tests and cost of medicines/ drugs, etc. The treatment cost was considered on the basis of prescription and the prices of medicines/drugs are taken as reported by the chemist. The practitioners provided the list of the drugs and duration of the treatment. The consultancy cost was considered as the average opportunity cost of consultancy in the open market. The cost of laboratory was considered as the average cost of five test centers near to the hospitals. Direct non medical cost includes expenditures incurred on transportation, lodging and meals during treatment as reported by the patient or their attendants.

Indirect costs represent cost for which no expenses were incurred but are associated with illness. This can be defined as the value of production lost to society due to temporary absence from work caused by illness. The cost of productivity lost has been determined by considering the per day income and the number of day lost due to sickness of the patient. For determining
the number of days lost in the age group of 10 to 25 and 60 and above, the number of days lost by the accompanying person and his earnings (if any) have only been taken into consideration.

The per episode total economic cost of the health affects during the period under the study for all diseases resulted from the various pollutants is estimated to be INR `49,45,539/-.

On comparing the economic cost of air pollution of various diseases, RB accounted for a higher economic cost INR `37,77,345/- being 76.38% of the total cost. The economic cost of AI INR `10, 26,483/- as compared to RB was much lower being 20.76% of the total cost. The economic cost of CEI INR `1,41,711/- was 2.86% of the total cost which is very insignificant as compared to other diseases.

On comparing the economic cost of the air pollution on the basis of direct and indirect cost component of COI it has been found that the direct medical cost estimated to be 48.02% of the total cost followed by indirect cost being 31.46% of the total cost.

The direct medical cost per patient is too high in AI as compared to RB and CEI. The per patient cost of AI amounts to INR `1,002.57/- in respect to direct medical cost followed by CEI which amounted to INR `896.52/- as direct medical cost. The per patient non medical cost was higher in AI which amounted to INR `393.12/- followed by RB which accounted to INR `327.82/-. Thus the total direct cost of treatment of AI diseases appears to be more costly as compared to other diseases due to costly medicine and tests.

The indirect cost of illness includes the productivity lost due to absence from work of the patient. The indirect cost is higher in RB which amount to INR `240. The number of days lost during sickness is greater in RB as compared to AI and CEI. This can also be reconciled with the fact that the patient of RB were bound to pay more visit for the purpose of treatment and also the treatment was carried for a longer period which resulted into higher cost of treatment.

One of the most commonly used methods for evaluating the cost of morbidity and mortality is to measure individual welfare change associated with the diseases by directly questioning with individuals about the willingness to pay (WTP) for improvement and treatment and prevention. A stated preference method to measure WTP was adopted based on Contingent Valuation
(CV). CV involved questioning individuals directly maximum amount they are willing to spend to have the commodity in question. WTP estimates requires a respondent to assess the prospects for expenditure on the basis of prior and present day experience to consider the prospects of eliminating the risk of infection given that the respondent have had recent experience with the diseases (recently suffering for the diseases) or potential to assess future possibilities that is to consider the possible cost of becoming infected whether or not they had any experience of the disease.

Out of 3,000 respondents 116 respondent were unwilling to pay amount to secure the risk. Out of the remaining 2,884 respondent 1,571 respondent were willing to spend between \textsterling} 1,001 to \textsterling} 2,500, a 563 respondent opted to spend \textsterling} 2,501 to \textsterling} 5,000, 482 respondent were eager to spend up to \textsterling} 1,000 and rest 268 respondent select the highest amount bid of \textsterling} 5,000 and above.

The study brings out the fact that due to high level of TSPM and PM$_{10}$, NO$_2$, a large number of cases were reported to be affected in Agra City by problems related to cardiovascular and respiratory diseases, lung cancer, and acute lower respiratory infections, chronic obstructive pulmonary disease, bronchitis in asthmatic, reduced lung function growth.

In order to control air pollution following measurers are recommended which can have a positive impact to lessen the burden of economic cost:

- Use of CNG as fuel for processing /production
- To replace DG sets with Gas generators.
- Restrict supply and usage of coal, coke, wood, rice husk, baggase to the industries situated in the city limit of Agra.
- All Petha Industries shall be operated by CNG/LPG only.
- Setting up of CNG/LPG retail outlets within Agra City for supplying CNG/LPG to the vehicles.
- Phasing out grossly polluting vehicles plying within the city.
- Checking for adulteration.
- Strict checking of vehicular emissions.
- Better traffic management.
- Construction paved footpaths / widening of roads up to the boundary limit along the major roads to minimize natural dust and congestion.
- Providing LPG for domestic and commercial use.

(Nitin Kishore Saxena)
Research Scholar
Department of Accountancy and Law
Faculty of Commerce

(DR. PRAVIN SAXENA) (PROF. PRAMOD KUMAR)
Supervisor Head
Department of Accountancy & Law
Faculty of Commerce
Dayalbagh Educational Institute

(PROF. PRAMOD KUMAR)
Dean
Faculty of Commerce
Dayalbagh Educational Institute