Indoor, Out Door Air Pollution (Ioap), Cost Effective Methodologies And Potential Intervention Strategies

Dr Muhammad Attique Khan Shahid[1*], Naveed Ahmad[2], Khadim Hussain[3], Nasir Ahmad[4]

[1*]Department of Physics, Govt. P/G College of Science, Faisalabad, Punjab, Pakistan
[2]Department of Physics,. University of Education, Lahore, Punjab, Pakistan
[3]Centre for High Energy Physics,. University of the Punjab, Lahore, Punjab, Pakistan
[4]Institute of Geology, University of the Punjab, Lahore, Punjab, Pakistan

(*) Corresponding author (profkhan786@yahoo.com)

Abstract: Many ambient air (out door) pollutants are also found in higher levels in work place environment (In door) that is why studies on exposure to pollutants found in the in door domestic environment are increasing and are contributing to an already significant compilation of data sets. Improvement in cost effective monitoring techniques has helped this process. This study is a humble attempt in this regard. Eighthourly average loading of outdoor suspended particulate matter (SPM) was found to be in the range of 670 to 1523 $\mu g/m^3$. Twenty-four hourly bulkdeposition of free fall dust was found to be varying from 16 to 60 gm/ m^2/month. Minerals, such as Quartz, Illite, Cholrite, Calcite, Albite, etc. were detected in all samples (SPM, free-fall dust, indoor suspended particles samples and carpet dust) using the Powder method. Elemental loadings of all samples were determined employing the atomic absorption spectroscopy. Cu, Ni, Cd, Zn and Pb were detected in all the samples. Since there are no ambient air quality standards enacted in Pakistan, a comparison with ambient air quality standards (WHO, USA, and Europe) showed that loading of airborne particulate matter were several times higher than the maximum permissible limits accepted there as standard. In this study the Pb concentration was found to range from 1 to 9.8 $\mu g/m^3$;Cu, Ni, Zn and Cd were within the permissible levels.

Key words: IOAP, cost effective methodologies, XRD, AAS, Intervention starategies, future recommendations.

INTRODUCTION

The history of studies of air pollution in Pakistan is not very old. About three decades ago, a global air monitoring program for the study of suspended particulates was launched by the World Health Organization as a part of Global Environment Monitoring System (GEMS). Some 50 countries participated in the program except Pakistan and data were collected from 175 sites of the participating countries. The GEMS results were later reported by WHO (1984); the results showed that the SPM concentrations for a Lahore commercial city centre were 332 $\mu g/m^3$ in 1978 and for a Lahore residential site were respectively 749 and 690 $\mu g/m^3$ in 1979 and 1980. Bennett et al. (1985) and Koning et al.

(1986) reported from the GEMS results that Tehran, Mumbai, and Calcutta were emerging as highly polluted cities in the southern Asia. In order to know the air pollution situation prevailing in Lahore at that time, Hussain et al. (1990) collected suspended particulates from different urban and suburban sites of Lahore and studied those by X-ray Powder Diffraction and Wet Chemical Analysis. Owing to nonavailability of any air volume sampler, mass concentration of SPM could not be found. Some samples were studied by Scanning Electron Microscopy for knowing the suspended particulate size. The X-ray Diffraction results showed the presence of soil minerals namely, albite, calcite, and quartz in the samples not in apportionment to the soils of the area. The approximate size of suspended particles as determined from SEM micrographs was found to be in the range between 1 µm to 10 µm. Particles of such size were indicated in the study to remain suspended in the air for long periods of time if not scavenged on account of microphysical processes of the atmosphere. In a later study on Lahore conducted in 1994 to assess any climate change in the area, the role of suspended particulates appeared to be evident because about 0.5°C rise in the average temperature of the city was observed from the analysis of 1950-1992 temperature data (Munir, et al. 1995). A group of Pakistani, Portuguese and British scientists studied SPM collected from Lahore (Pakistan), Coimbra (Portugal) and Birmingham (Britain) for knowing their mass concentration, phase and elemental analysis (Smith et al. 1995; Smith et al. 1996; Smith and Harrison 1996; and Harrison et al. 1997). The co-workers reported mass concentrations of SPM and 24 elements in the samples of Lahore (Pakistan), Birmingham (UK) and Coimbra (Portugal). The SPM concentrations in these cities were respectively $607\mu g/m^3$, $47.0\mu g/m^3$ and $52.1\mu g/m^3$. As we quantified the elements Cu, Cd, Zn, Pb and Ni in the samples we collected, we mention here the mass concentrations of these metals only. Cu was respectively 0.420 and 0.0402 $\mu g/m^3$ for Lahore, Birmingham and Coimbra, Cd was respectively was 0.00924 and 0.00176 $\mu g/m^3$ for Lahore, Birmingham and Coimbra, Zn was respectively 277.0, 0.353 and 0.070$\mu g/m^3$ for Lahore, Birmingham and Coimbra, Pb was respectively 3.920, 0.0091 and 0.0031 $\mu g/m^3$ for Lahore, Birmingham and Coimbra, and Ni was re-

spectively 0.0797, 0.0048 and 0.0061$\mu g/m^3$ for Lahore, Birmingham and Coimbra. In another study carried out on Lahore SPM in April 5-10, 2000, SPM concentration (hourly average) as high as 895$\mu g/m^3$ was reported by Pak-EPA/JICA (2001).

In recent years, airborne particulates collected from Lahore during January 2007 to January 2008 were studied by a group of Pakistani and American scientists with the major objectives of samples' chemical characterization and source apportionment, and determination of coarse (PM_{10}: 2.5-10 µm) and fine ($PM_{2.5}$: <2.5µm) particulates concentrations and toxic metal loadings (Fang et al. 2000; Zhang et al. 2008; Schneidemesser et al. 2010). Their first paper (Zhang et al. 2008) showed that dust was the major contributor to the PM_{10} suspended particulates with minor contributions from man-made sources. The PM_{10} concentration was found to behigh with the average value of 459 $\mu g/m^3$. In another publication(Schneidemesser et al. 2010), extremely high concentrations of Pb (4.4$\mu g/m^3$), Zn (12$\mu g/m^3$) and Cd (0.077$\mu g/m^3$) were reported. These metals were found to be respectively 84%, 98% and 90% in fine particles ($PM_{2.5}$ and smaller). Annual average $PM_{2.5}$ and PM_{10} concentrations were reported to be 194±94 $\mu g/m^3$ and 194±94$\mu g/m^3$, respectively, with daily 24-hour maximu m concentrations of 410 $\mu g/m^3$ and 650 $\mu g/m^3$ for $PM_{2.5}$ and PM_{10} respectively (Stone, et al., 2010). Coarse aerosol ($PM_{10-2.5}$) was dominated by crustal sources like dust (74 ± 16%), whereas fine particles were dominated by carbonaceous aerosol (organic matter and elemental carbon, 61 ± 17%). To determine likely categories for source apportionment, seven factors including a number of industrial sources, re-suspended soil, mobile sources, and regional secondary aerosol were identified explaining 91% of the variance of the measured components (Schneidemesser, et al. 2010).

Other important recent references which reported SPM concentrations for Lahore and other Pakistani major cities are Waheed et al. (2005, 2006), Ghauri et al. (2007), Lodhi et al. (2009), Ali and Ather (2010) and Alam et al.(2010). In the study by Waheed et al. The SPM levels in Lahore were 1128-1870 $\mu g/m^3$. In the study of Ghauri et al mean PM_{10}

conentrations (24h-average) were 200 μg/m^3 for Lahore, 193 μg/m^3 for Karachi, 185μg/m^3 for Rawalpindi and 219μg/m^3 for Peshawar. Lodhi et al. (2009) reported PM$_{2.5}$concentrations for Lahore as , 191μg/m^3 and 143μg/m^3 respectively in the winter and spring. Ali and Ather(2010), using a high-volume sampler obtained PM10 concentrations from a three-day average during the months of April and May and those to be 660μg/m^3. Raja et al.(2010) worked on Lahore SPM between Nov. 2005 and Jan.2006 and focused their study for determining percent fine particles (PM$_{2.5}$) concentrations larger than 200μg/m^3, between 200μg/m^3 and 100 μg/m^3 and below100 μg/m^3, They report that, for these three ranges, te fine particle concentrations were 36%, 52 % and 12% respectively. In a more recent study by Alam et al. (2011), using an optical particle counter found 24-hour average PM10 concentrations for Lahore, Karachi, Rawalpindi and Peshawar respectively as 198μg/m^3,461μg/m^3, 448μg/m^3 and 540μg/m^3. The corresponding 24-hour average PM$_{2.5}$ concentrations for these cities were91μg/m^3, 185μg/m^3, 140μg/m^3 and 160μg/m^3 respectively.

It should be mentioned that the results of the studies on Lahore with particular reference to SPM mass concentration and their phase and elemental analyses are sporadic; the studies were carried out on eight occasions between 1978 and 2010. Some occasional data have also been reported in literature for other major cities of Pakistan, namely Karachi, Quetta, Faisalabad, Gujranwala, Rawalpindi, Islamabad, and Peshawar, but we have mentioned it here. However, SPM mass and elemental concentrations reported in the literature carried out in some major Asian, European and American cities are also reproduced in **Table 2K01** for comparison with Lahore data mentioned above and that we have included in this paper.

The results on Lahore given in this paper were obtained during December 2001 to January 2002 and are compared with the previously reported results, in which some studies were carried out after January 2002. The crux of the comparison is actually to bring on record the pollution situation which prevailed during December 2001 to January 2002 in Lahore. *At that time the authors did not publish the results as little was known about the pollution scenario of Lahore.*

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Table 2K01. Mass Concentrations (µg/m^3) of Suspended Particulates in World Major Cities

Area/City/Country	Fine (PM2.5)	Coarse (PM10)	Reference
Helsinki (Finland)	11.8	12.8	Pakkanen et al. (2001)
Nanjing (China)	481.4	774.5	Wang et al. (2002)
Hon Kong	Daily Ave.: 42.37 – 57.38 Highest 116.89	Daily Ave.: 73.1 – 83.52 Highest 125.89)	Ho et al. (2003)
Four Locations in Southern Tainan(Taiwan)	31.0±7.8 40.1±10.8 44.3±9.1 43.7±17.1	49.6± 12. 62.1±14.5 72.5±16.5 74.5±14.6	Tsai and Chen (2006)
London & Birmingham (UK) PM2.5: 8.0	Mean	Mean Roadside PM10: 34.7 Mean Urban PM10: 23.2 Ave. PM10: 11.5	Harrison et al. (2004)
EU Regions	37 to 53 at	28 to 42 at urban background; Kerbsidesites.	Querol, et al. (2004)
Athens, Koebel and New Albany (USA)	Outdoor 13.66± 8.91, 13.89±9.29, 12.72± 8.86 Indoor 17.20±13.56, 14.98 ±12.30, 16.52 ±13.53		Crist et al. (2008)
Oslo (Norway)	Mean: 25.4±16.5. Higher conc. in summer: PM2.5, 27.9±8.7 (2004) and 27.8±9.7 (2005). Lower concentration in winter PM2.5, 21.0±13.0 (2004/2005) and 21.4±21.9 (2005/2006)].	Mean: 35.0±17.7, Higher conc. in summer: PM10, 38.7±10.8 (2003); Lower concentration in winter PM10, 28.7±22.5 (2003/2004);	Lazaridis, et al. (2008)
Leicester (UK)	10.9 ±5.7	22.1 ±9.8	Gulliver and Briggs (2007)
A traffic sampling site (Central Taiwan)	Daytime daily ave.:39.17 Nighttime daily ave.: 37.15	Daytime daily ave.: 34.35 Nighttime daily ave.: 33.72	Fang et al. (2006)

Measurement of suspended particulate matter (SPM) in air, is often difficult; partly because of the variety of the compound phases and trace metals of potential concern, and partly due to the variety of available experimental techniques for sample collection and lack of standardized and documented methods. The Compendium is one of three Compendia of methods which produce documented and technically reviewed methodology for determining concentrations of selected pollutants of special interest in the ambient air of Lahore, Pakistan. The methods contained in this compendium provide cost-effective sampling procedures for suspended particulate matter. These methods are provided only for consideration of researchers to use in applications for which they may be deemed appropriate. Especially, these methods are not intended to be associated with any specific regulatory monitoring purpose and are offered with no specific endorsement for fitness and recommendation for any particular application; other than for an attempt at standardization. This manuscript has been submitted for publication to provide easiest approach for sample collection and information transformation to facilitate the scientific community and young researchers involved in atmospheric and Environmental Physics related studies, especially, in under-developed and developing countries like Pakistan.

Particulate matter pollution has emerged as a serious environmental health concern in Pakistan, The use of biomass fuels, sui gas, electromagnetic instruments, different type of chemical sprays and paints in homes produces not only high levels of indoor air polluitants but also increase global warming and consequently increase in the incidents of diseases like eye irritants, respiratory infections, sinus problems, headaches, asthma and allergies and disrub the friendly atmosphere of the homes and work places. Therefore intervention to reduce indoor level pollution is must. This study investigates variations in indoor, outdoor concentrations of particulate matter during various activities for different micro and macro environments of selected areas of Lahore, Pakistan.

2. SAMPLING AND METHODOLOGY

2.1 Sampling of Outdoor, Indoor Suspended Particulate Matter and Free Fall Dust

Samples of three different categories were collected from various locations of the metropolitan city of Lahore. Those are outdoor suspended particulates (SPM), indoor suspended particulate matter (SPM) and freely falling dust (FFD).A portable high volume sampler was used to collect outdoor SPM samples at thirteen different sites and indoor SPM at five locations. Whatman 41 cellulose and Millipore glass filters were used to capture the particulates. Air was drawn through the sampler by an inbuilt sucking pump for the durations of an average period of 8 hours and 24 hours. Flow rate was initially set at 38 l/min which gradually decreased due to clogging of filters but was kept close to it. The range of the sampling rate however remained in the range of 28- 38 l/min. At all sites/locations sampling was accomplished keeping sampler at the same height. The sampling was carried out during the months of December 2001 and January 2002. The filters were dried in oven at about $105^{o}C$ before sampling and then analyzed to compute metallic loadings in $\mu g/m^3$. During the sampling of particulate matter, meteorological parameters like temperature, relative humidity, atmospheric pressure, wind speed and wind direction were also recorded.

Indoor SPM was collected on air conditioners filters installed in the houses. Dusts from the floor carpets and house courtyards were also collected from some houses in the sampling locations. Prior to collection of particulates from indoor air, air conditioner filters were cleaned and washed. The particulate matter deposited on the filters during the summer of 2002 were collected and strained for removal of fibrous material. Likewise, vacuum cleaners were also cleaned and washed before using them to suck carpet and courtyard dust.

In order to determine the deposition flux for free fall dust, falling dust was also collected using open plastic buckets wetted with de-ionized water to facilitate the capturing of gravitationally settling particles.

2.2 Methodology for Analysis

2.2.1 Trace Metal/Element Analysis using AAS technique

Trace element contents of the samples of all categories were determined using Atomic Absorption Spectroscopy (AAS). A Shimadzu Atomic Absorption/Flame Spectrophotometer (Model No.AA-630-12) was employed for the analysis.

2.2.1 Phase Analysis of Samples using XRD tech-

nique

Identification of phases in all categories of samples was determined sing the X-ray Diffraction (XRD) technique. The samples were then kept in dry bottles before their XRD analyses were carried out. A Siemens Powder X-ray Diffractometer (Model D 5000) was employed in the present study. Each sample was pressed gently to make pellets and then loaded in the diffractometer goniometer. Qualitative phase analysis was carried out at the Center for Excellence in Solid State Physics, University of the Punjab, Lahore employing the Hanawalt method and using the Powder Diffraction File of the International Commission of Diffraction Data.

3. RESULTS

3.1 Mass concentration of Suspended particulate matter

Daily average concentration (eight-hourly mean) of all SPM samples collected from different locations in the metropolitan city of Lahore was determined from the sampling flow rate and the sampling time. The results are given in **Table 2K02** and plotted in **Fig. 1**. The mean concentration of SPM varied from 670 μg/m^3 to 1523 μg/m^3 with an overall average value of 1091±260 μg/m^3. The lowest concentration of 670 μg/m^3

Table 2K02: Concentration of Total Suspended Particles at Different Locations

Locations	Daily Average Concentration*(μg/m^3) with SDEV
Walton	860
Shadman	1350
Town Ship	745
Misri Shah	1192
Charring Cross	1192
City Railway Station	1523
Bhatti Chowk	854
Mozang Chungi	670
Niazi Chowk	1308
Shehzan Factory (Bund Road)	1104
Chauburji Chowk	1210
Mean with Standard Deviation	1091±260

*Daily mean value for one month

was found for Mozang Chungi whereas the highest concentration of 1523 μg/m^3 was found for City Railway Station. These concentrations are one to three times higher than Pak-EPA (twenty-four hourly) standard value for SPM which is 500 μg/m^3 (Pak-EPA, 2012). However SPM concentrations reported previously for Lahore were between 332 and 749 μg/m^3 (WHO, 1984), 607 μg/m^3, 590 μg/m^3 and 838 μg/m^3 respectively for Lahore city centre, industrial and rural locations (Smith et al. 1995; Smith et al. 1996; and Harrison et al. 1997), 895μg/m^3 (Pak- EPA/JICA, 2001), and 1128-1870 μg/m^3 (Waheed et al. 2006). The later data reported for Lahore specified PM10 and PM2.5 show SPM concentrations as 851 μg/m^3 (PM10: 660 μg/m^3; PM2.5: 191 μg/m^3) (Lodhi et al.2009) and 289 μg/m^3 (PM10: 198 μg/m^3; PM2.5: 91 μg/m^3) (Alam et al. 2011). The present concentrations are also much higher than these

data. All SPM values reported in the literature cited above and the present result are higher than the Pak-EPA current SPM Pak-EPA Standards. The present SPM mass concentrations are also compared with the major world cities concentrations of PM10 and PM2.5 (**Table 2K01**). The present concentrations are much higher than the word data except for Beijing (China); these later concentrations are comparable to the present data.

All SPM samples were analyzed by the X-ray Powder Diffraction (XRPD) Technique to determine the constituent phases and by Atomic Absorption Spectroscopy (AAS) to determine the metallic traces. The XPRD results show that in all the samples the phases present in variable amounts are the soil-derived minerals, namely, Quartz, Illite, Calcite, Cholrite, Albite, Talc and Gypsum. Kaolinite was not however indicated in any SPM sample. These results are in agreement with many similar studies reported previously.

3.2 Free Fall Dust Flux using Open Bucket Method

Freely falling dust was collected using open plastic buckets wetted with de-ionized water to facilitate capturing of the falling particles. The deposition rate of freely falling dust for all the sampling sites are given in **Table 2K03**. Phase analysis carried out by the XRPD technique indicated the same minerals as detected in the SPM samples. **Table 2K03** shows that the rate of deposition of free fall dust at different sites varied from 20 tons/km^2/month to 45 tons/km^2/month with the average value of 30.7 tons/km^2/month. The average contents of dust are six times higher than the permissible limits (5 tons/km^2/month) (Ahmad et al. 2006).

Table 2K03: Deposition flux of free fall dust at different locations

Location	Free fall dust	
	Tons/km^2/month	Tons/km^2/year
Walton	23.9	286.9
Shadman	32.0	384.0
Town Ship	30.0	360.0
Misri Shah	45.0	540.0
Mozang Chungi	20.0	240.0
Shehzan Factory	42.0	504.0
Chuburji Chowk	22.0	264.0
Mean with Standard Deviation	30.7±9.7	368.4±117.0

3.3 Elemental Analysis of Outdoor Suspended Particulate Matter(High Volume Air Sampler and Open Bucket Method)

Elemental concentrations of the outdoor particulate matter are given in **Table 2K04.** The Pb content appears to fall in the range from 0.7 to 6.1 μg/m^3 and much higher than the Pak-EPA 2012 standards for Pb in the ambient air (annual average: 1μg/m^3 and 24-hr average: 1.5 μg/m^3. Concentrations of Cu and Zn were respectively found as 0.19±0.14 and 0.79±0.40μg/m^3. As permissible values of these elements were not available in literature, we have nothing to compare with the present data. Elemental loadings of free fall dust are recorded in **Table 2K04** which shows high values of Pb in the samples ranging from 81 μg/m^3 to 724 μg/m^3. High lead content of both SPM and free fall dust is evidently due to voluminous traffic size and use of high lead content fuel. The high content of lead in petrol is a serious issue, as the end product of it is the release of lead into the environment. In Pakistan presently the lead content in regular super premier and HOBC petrol is reported to be 0.63 and 0.84 g/liter, respectively (Baluchistan Conservation Strategy, 2000 and Lovei, 2000).

3.4 Elemental Analysis of indoor suspended particulate matter (Using AC Filters and Vacuum Cleaners)

As mentioned in the methodology, indoor suspended particles were collected using air conditioner filters. Dust was also collected from carpets using pre-cleaned vacuum cleaner. The elemental analyses of both types of samples collected from all sites are given in **Tables 2K06, 2K07** respectively. Here again in both types of these samples the Pb loadings are the highest; in the range 14 to 979mg/kg for AC filters and 79 to 390 gm/kg for carpet dust. We find that Pb concentrations are much higher in free fall dust, AC dust and carpet dust than in the SPM samples.

4. DISCUSSION

The average concentration of SPM at various sites in Lahore was 1092±272 μg/m^3 which is much higher than the Pak-EPA standard values made public in January 2012. The average deposition flux of free fall dust was30.7±97 tons/km^2/month ,which is also much higher than the permissible value of 5 tons/km^2/month. As the number of vehicles has increased many fold in recent years, all vehicles in general and those with poor conditions

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in particular release suit particles and are thus another big source of airborne particulate matter(Valipour, et. Al., 2013, Valipour, 2012[a,b])

The elements detected in SPM show that the Pb concentrations are several times higher than other

Table 2K04: Elemental concentration in suspended particles from different locations

Location	Concentration ($\mu g/m^3$)				
	Cu	Zn	Cd	Pb	Ni
Walton	0.1	0.2	ND	0.7	ND
Shadman	0.07	0.4	ND	2.5	ND
Town Ship	0.2	1.0	0.02	3.0	ND
Misri Shah	0.4	1.4	0.02	6.1	ND
Chairing Cross	0.1	1.1	ND	4.5	ND
Ichhra	ND	1.0	ND	1.3	ND
Bhatti Chowk	0.1	0.9	0.07	5.0	ND
Mozang Chungi	0.06	0.3	ND	3.8	ND
Shehzan Factory (Bund Road)	0.4	1.0	ND	3.7	ND
Chuburji Chowk	0.3	0.8	ND	4.0	ND
Rang Mahal	0.1	0.9	0.02	5.5	ND
Mean with SD	0.19	0.79±0.40		3.7±1.5	

ND: Not Detected

Table 2K05: Element Loadings of Free Fall Dust

Locations	Concentration of elements in free fall dust ($\mu g/m^3$)				
	Cu	Zn	Cd	Pb	Ni
Walton	21	26	0.4	81	10
Shadman	24	23	0.8	280	40
Township	76	24	0.8	764	30
Mozang Chungi	22	30	0.5	124	19
Shehzan Factory	80	30	0.7	724	35
Chauburji Chowk	230	50	1.2	590	30
Mean with SD	75.5±80.5	30.5±10.0	0.73±0.30	427.2±303.8	27.3±11.0

elements, namely Cu and Zn and also higher than allowable Pb concentrations (Pak-EPA, 2012).The major source of Pb is the heavy vehicular traffic plying about 18 hours a day on city roads which use petrol and diesel as fuels. There are several sources of Cu, Cd and Zn including brakelining, burning of fossil fuels in motor vehicles and industrial/urban areas, flyash of power plants, rubber tyres and asphalt (ECE, 2007; Sorme et al. 2001; Davison et al. 1974 and Richard et al. 1974).

The Pb concentrations appear to show almost a positive correlation with the SPM concentrations for all samples. There is no correlation between Cu and SPM concentrations and Zn and SPM concentrations for all samples. It appears therefore that the suspended particulates derive their Pb loadings from some potential source like leaded petrol, the consumption of which has increased manifold during recent years because of larger number of vehicles plying on the Lahore city roads. The sources of Cu and Zn do not appear to be permanent; they vary

from place to place in the city.(Valipour,2012, Valipour et.al., 2012)

It is evident from these results that showing elemental loadings of free fall dust that the Pb concentration is higher than the other elements. Like SPM samples Pb and Ni loadings of the free fall dust appear to exhibit a positive correlation with the dust concentration. Elemental analysis of AC dust samples and carpet dust samples also show Pb as highest of all the elements detected in these samples.

It is also evident that elemental loadings of free fall dust that the Pb concentration is higher than the other elements. Like SPM samples Pb and Ni loadings of the free fall dust appear to exhibit a positive correlation with the dust concentration. Elemental analysis of AC dust samples and carpet dust samples also show Pb as highest of all the elements detected in these samples.

These findings also indicate higher SPM concentrations in the present study. Because of scarcity of the data points it is not possible to comment on the variability of the SPM concentrations over the years.

The present study shows that the SPM average (24-hr) concentration in Lahore is 1091 ± 260 μg/m^3 and the average (24-hr) concentration of Pb is 3.7 ± 1.5 μg/m^3. The present particulate matter concentration values are much higher than those given in Table 2K01 and in air quality standards of Pak-EPA (2012) (SPM: 500 μg/m^3), India-NAQS (2009) (SPM: 500 μg/m^3-Industrial; 200 μg/m^3-Residential), US-NAAQS (2012) (PM10: 150 μg/m^3; PM2.5: 35 μg/m^3), WHO-AAQS (2011) (PM10: 50 μg/m^3; PM2.5: 10 μg/m^3), and ECE-AAQS (2013) (PM10: 50 μg/m^3). The Pb concentrations found in the present study are also much higher than the standard values for Pak-EPA (2012), US-NAAQS (2012) (2 μg/m^3-2011, 24-hr standard; 1.5 μg/m^3-2012, 24-hr standard), India-NAQS (2009) (1.0 μg/m^3-24-hr standard of 1994), WHO-AAQS (2011) (0.35 μg/m^3, 24-hr upper assessment threshold; 0.25 μg/m^3, 24-hr lower assessment threshold), and ECE (2013) (0.5 μg/m^3). It needs to be mentioned that the higher concentration of SPM measured in 2003 appears to be due to construction of the ring road around the entire Lahore metropolitan city. The total length of the ring road is around 80 km. As mentioned above, the SPM concentrations before and after 2003 are much lower than the 2003-values.

The study indicates that the major sources of air pollution in Lahore appear to be both natural and anthropogenic; heavy vehicular traffic plying on

Table 2K06: Elemental Loadings of A.C. Filters

Locations	Concentration of elements in A.C. Filter Dust (mg/kg)				
	Cu	Zn	Cd	Pb	Ni
Walton	24	23	0.4	14	14
Shadman	63	23	0.4	130	9
Township	17	23	1.0	240	19
Misri Shah	12	25	1.5	520	21
Charring Cross	15	24	2.0	979	29
Mean with SD	26.2±21.0	23.6±0.9	1.06±0.69	376.6±385.5	18.4±7.5

Table 2K07: Elemental Loadings of Carpet Dust

Locations	Concentration of elements in Carpet Dust (mg/kg)				
	Cu	Zn	Cd	Pb	Ni
Walton	13	13	0.4	75	15
Shadman	16	21	0.3	190	15
Township	11	18	0.3	70	28
Misri Shah	23	22	0.5	142	18
Chairing Cross	28	26	0.3	390	30

Mean with SD	18.2±7.1	20.0±4.8	0.36±0.09	173.4±130.9	21.2±7.3

industrial units, small and large, situated around Lahore mostly along 'bund' road part of the ring road and Kot Lakhpat Industrial Estate not only cause higher concentration of SPM but also add Pb and other metals such Cd, Ni, Cu, Zn, etc. into the air through burning of fossil fuels and industrial activities. It needs to be mentioned that the vehicle population in Lahore has been growing at the rate of 10% with 72% of vehicles being diesel driven (PEPD, 2000). Air pollution, therefore, appears to be one of the rapidly growing environmental problems in the metropolitan city of Lahore.

Contrary to previous studies it was found that the SPM samples, collected from different methods, have almost same identified phases and trace metals. This indicates that the environment has its own local zones where the climatology and meteorology has no significant effect on dispersion of SPMs i.e., uniformity and homogeneity of the environment is confirmed. Furthermore, same compositions and trace metals make up of the suspended particulate matter also confirms that the three methods used in this study serve the same purpose. Hence, one can use the method of his own choice, keeping in view the availability of the funds in hand and according to the prevailing conditions of the study. In this way, this study will prove to be a breakthrough towards cost-effectiveness for the under-developed and developing countries, especially, Pakistan(Shahid et. al., 2013[a, b, c, d], Shahid et. al., 2014).

4.1 Potential Intervention Strategies

Using the steady state equation

$$C_{in} / C_{out} = P_a / a + k$$

With P = 1, k = 0.4 to 1, a =7.30/hr, Indoor, outdoor pollution was interlinked and the indoor, outdoor ratio RIO, far each set of data was calculated. The ratio is greater then 1 which is the indication that the indoor air quality is not better than outdoor,s as people think and implied that there might be major sourses of indoor pollution like smoking, cooking, cleaning soaps and detergents along with e-m instruments such as microwave ovens, deep freezers, air conditioner, vacuum cleaners. Therefore indoor air quality should be concerned urgently and thoroughly. Theoretically good correlation indicates that the trace elements have their indoor concentrations impacted

mainly by the infiltration of corresponding elements of outdoor air while week corelationship implies much higher removal rate of corresponding elements during the penetration of outdoor air or closing of doors/windows to prevent the outdoor pollution or excess of indoor sources of these elements, the three factors often accompanied by RIO < 1, RIO > 1, RIO ~ 1 respectively. Combination of co-relation with corresponding RIOs, it appeared that when RIO > 1 or RIO < 1 the co-relation b/w indoor and outdoor concentrations were more likely not so good but also increase global warming and consequently increase in the incidence of diseases. Therefore intervention to reduce indoor land pollution is must. Indoor pollution reduction strategy can be classified as The source of pollution, The home environment And the appliance user behaviour. Switching to cleaner fuels and safe use of sprays, paints and electromagnetic appliances may be the good option but the choice of house hold energy depends upon the level of available infra structure, environmental culture and socio economic factors. Various programmes have been launched to over come the issue like use of anti pollutant additives in natural paints that can turn any newly painted wall surface in to a friendly air source, the system is an ideal one in which neither any type of filters are involved nor the electricity is needed. This strategy permanently maintains healthy indoor air quality and remove all types of offensive odors, it is safe, effective, and permanent suggested solution for unhealthy environment but due to random results complete success has not yet been achieved. The main reason for the same was found to be the complexity of the procedures and methodologies adopted so far for developing and implementing a strategic approach at community level. More rigorous attempts will be needed to over come the said discrepencies and effective implementation of the proposed strategies.

4.2 Important Conclusions and Future Recomendations

Daily eight-hourly mean concentrations of SPM were found to vary from 670 to 1523 μg/m^{3}with an average of 1091μg/m^3. These concentrations are higher than 24-hr standards for Pakistan (550 μg/m^3; 500 μg/m^3 (Pak-EPA, 2012)). These concen-

trations are found to be much higher than the permissible limits provided in the air quality standards of India, US, and ECE. Minerals like Quartz, Illite, Calcite, etc. were found in all the SPM samples.

Elemental analysis showed an alarmingly high Pb content in the suspended particulate matter, free fall dust, dust of air conditioner filters, and carpet dust. Heavy vehicular traffic and industrial units located along the 'bund' road and in Kot Lakhpat appear to be the contributors to the high Pb content in all types of samples.

Through out the modern world now it is a well established fact that work place air pollution has a negative effect on human health. How ever the complete data on this issue is not available due to lack of public awareness which makes policy matters and regulatory approaches very difficult. To overcome this difficulty, following four areas of research were suggested for future studies;

1. Improvement in indoor, out door dose response relationships
2. Update association and dissociation of informative linkage
3. Co-relationship between child and adult health hazards
4. Better house hold informations to find a link between house hold fuels and health hazards including sick building syndromes.

The said areas were selected keeping in view the strategy adopted by WHO, UNEPs through global environment monitoring system (GEMS) with following objectives;

1. Demonstration of personal monitoring techniques that measure exposure to air pollutants
2. Comparison of findings between indoor, outdoor and personal exposure measurements
3. Comparison of human exposures to air pollutants in cities with different pollution profiles, climates and life styles

It is hoped that if these measures were adopted seriously this will inturn improve management of indoor environments resulting in improvements in health. Such type of actions have already been taken by the developed countries. The need in developing countries has yet not felt seriously.

In a nutshell, it is possible to conclude that all methods can be used for sample collection. However, the choice must be made between one and the other to obtain specific results. Additional testing and comparison of all methods is proposed to obtain more confidence with results and conclusions.

REFERENCES

Ahmad, M., Usman, M., Ahmad, N., and Shafiq, T. (2006): Dispersion gradient of free fall dust and heavy metal elements concentrations in dust along a main road, J. Chem. Soc. Pak., 28 (6): 567-575.

Alam, K., Blaschke, T., Madl, P., Mukhtar, A., Hussain, M., Trautman, T. and Rahman, S. (2011). Aerosol size distribution and mass concentration measurements in various cities of Pakistan. J Environ Monit. 13,1944-52.

Ali, M., Athar, M. (2010). Impact of transport and industrial emissions on the ambient air quality of Lahore city, Pakistan. Environ Monit Asses. 171, 353–63.

Baluchistan Conservation Strategy, Government of Baluchistan and IUCN Pakistan, 2000.

Bennett, B.G., Kretzschamar, J.G., Ak-land, G.G. and de Koning, H.W. (1985). Urban air pollution worldwide. Environ. Sci. Technol., 19, 298-304.

Crist, K. C., Brian, L., Myoungwoo, K., Seemantini, R., Deshpande, K. J. (2008). Characterization of fine particulate matter in Ohio: Indoor, outdoor, and personal exposures, Environmental Research, 106 (Issue 1), 62–71.

ECE-AAQS (2013). European Environmental Commission.

Fang Guor-Cheng, Wen Chih-Chung, Lee Wen-Jhy, (2006). Apply appropriate statistic methods in analyzing ambient air particulate and metallic elements concentrations at a traffic sampling site. Journal of Hazardous Materials, 137 (Issue 3), 1502–1513.

Fang, G-C., Chang Cheng-Nan, WuYuh-Shen, Wang Nai-Phon, Wang Vicky, Fu Peter Pi-Cheng, Yang

Ding-Guor, Chen Shun-Chin (2000). Comparison of particulate mass, chemical species for urban, suburban and rural areas in central Taiwan, Taichung. Chemosphere, 41, 1349-1359.

Ghauri B., Lodhi A., Mansha M. (2007). Development of baseline (air quality) data in Pakistan, En-

viron. Monit Assess., 127, 237-52.

Gulliver J., Briggs D. J. (2007). Journey-time exposure to particulate air pollution. Atmospheric Environment, 41, 7195-7207.

Harrison, R. M., Jones, A. M. and Lawrence, R. G. (2004). Major component composition of PM10 and PM2.5 from roadside and urban background sites. Atmos Environ, 38, 4531-4538.

Harrison, Roy M., Smith, D.J.T., Piou, C.A., Castro, L.M., (1997). Comparative Receptor Modelling Study of Airborne Particulate Pollutants In Birmingham (United Kingdom), Coimbra (Portugal) And Lahore (Pakistan). *Atmospheric Environment,* 31, 3309-3321.

Ho, K.F., Lee, S.C., Jimmy, C.Y., Zou, S. C., Fung, K., (2002). Carbonaceous characteristics of atmospheric particulate matter in Hong Kong. The Science of the Total Environment, 300, 59–67.

Hussain, K., Riffat, R., Shaukat, A., Siddiqui, M. A., (1990). A Study of Suspended Particulate Matter in Lahore (Pakistan). Advances in Atmospheric Science, 7, 178-185.

Indian-NAQS (2009). National Air Quality Standards, Central Pollution Control, Board Notification, New Delhi.

Khan, A., Blaschke, T., Madl, P., Mukhtar, A., Hussain, M., Trautmann,T., Rahman S.., (2011). Aerosol size distribution and mass concentration measurements in various cities of Pakistan. J Environ Monit., 13,1944-52.

Koning, D. H. W., Kretzschmar, J. G., Akland, G., Bennet, B. G. (1986). Air pollution in different cities around the world. Atmos. Environ., 20, 101-113.

Lazaridis, M., Aleksandropoulou, V., Hanssen, J. E., Dye, C., Eleftheriadis, K., Katsivela, E., (2008). Inorganic and carbonaceous compondents in indoor/outdoor particulate matter in two residential houses in Oslo, Norway. Journal of Air Waste Management Association, 58, 346-356.

Lodhi, A., Ghauri, B., Khan, M. R., Rehman, S., Shafique, S. (2009): Particulate matter (PM2.5) concentration and source apportionment in Lahore. J Braz Chem Soc. 20, 1811-20.

Lovei, M., Phasing our Lead from Gasoline: Worldwide Experience and Policy Implications paper No. 040, ESD, The World Bank, Washington 1996 HB Strategy paper, 2000.

Munir, M. M., Hussain,K., Zafar, M. S., (1995). Analysis of surface air temperature recorded in Lahore and Mianwali over the past decades. Acta Meteorologica Sinica, 9 (1), 123-128.

Pak-EPA /JICA (2001). Pakistan Environmental Air Quality and Emission Standards, JICA-Pak-EPA, May 2001.

Pak-EPA (2011). Comprehensive Environmental Monitoring Report For Selected Pilot Areas in Pakistan (From the Results of TCP-EMS Trainings), February 2009 – December 2011.

Pakkanen, T. A., Loukkola Kati, Korhonen Christina H., Aurela Minna, (2001). Coarse particles in the Helsinki area. Atmospheric Environment, 35, 5381–5391.

PEPD (2000): Pakistan Environmental Protection Department, Islamabad.

Querol, X., Alastuey, A., Ruiz, C.R., Artiñano, B., Hansson, H.C., Harrison, R.M., Buringh, E., ten Brink, H. M., Lutz, M., Bruckmann, P., Straehl, P., Schneider, J., (2004),. Speciation and origin of PM$_{10}$ and PM$_{2.5}$ in selected European cities. Atmospheric Environment, **38**, 6547–6555.

Raja, S., Karabi, S., Hussain, L., Hopke, Philip K., (2010). Source apportionment of the atmospheric aerosol in Lahore, Pakistan, Water Air Soil Pollution, 208, 43-57

Richard, L. Davison, D., Natusch, F. S. , Wallace, John R., Evans Jr., Charles A., (1974). Trace Elements in Fly Ash: Dependence of Concentration on particle Size. Environmental Science and Technology, 8 (13),1107-1113.

Schneidemesser Erika von, Stone Elizabeth, A., Quraishi Tauseef A., Shafer Martin, M. and Schauer James J. (2010). Toxic Metals in the Atmosphere in Lahore, Pakistan, Science of the Total Environment, 408, 1640-1648.

Shahid, M. A. K., Ahmad, N., Hussain, K., and Naseem, S. (2013) [a] Compound phase analysis of solid aerosols collected from different locations of Faisalabad and Lahore (Pakistan) using Matrix-Flushing Method. Peak Journal of Physical and Environmental Science Research Vol. 1(5), pp. 54-65.

Shahid, M. A. K., Hussain, K., and Raza, A., (2013) [b]. Characterization of organic and in organic compounds in the atmosphere of Faisalabad on the basis of pooling and zoning technique by X-ray powder diffraction (XRPD). Peak Journal of Physical and Environmental Science Research Vol.1 (5), pp. 66-82.

Shahid, M. A. K., and Hussain, K., (2013) [c]. X-ray diffractometric examination and elemental composition of solid aerosols collected from different

zones of Faisalabad (Pakistan) by Matrix-Flushing Method. International Journal of Chemistry and Material Science Vol. 1(9), pp. 210-225.

Shahid, M. A. K., and Hussain, K., Raza, A., and Maryam, S. A., (2013) [d]. Levels of trace metals in the atmosphere of Faisalabad and human risk assessment. PJMMS, Vol 1(7). 63-68.

Shahid, M. A. K., Hussain, K., Maryam, S. A., and Raza, A., (2014). Elemental Analysis of Solid Aerosols Using AAS Technique And Estimation of their Effect on Atmospheric Radiation Budget. Pak. J. Engg. & Appl. Sci. Vol. 14, Jan., 2014 (p. 57-72) 57.

Smith, D. J. T. and Harrison, R. M. (1996). Concentrations, trends and vehicle source profile of polynuclear aromatic hydrocarbon concentrations in the UK atmosphere. *Atmospheric Environment,* 30, 2513-2525.

Smith, D. J. T., Edelhauser, E. C., Harrison, R. M., (1995). Polynuclear aromatic hydrocarbon concentrations in road dust and soil samples collected in the United Kingdom and Pakistan. Environ Technol, 16, 45–53

Smith, D.J.T., Harrison, Roy M. , Luhana, L., Pio, Casimiro A., Castro, L.M. , Tariq, M. N., Hayat, S., Quraishi, T. (1996) Concentrations of particulate polycyclic aromatichydrocarbons and metals collected in Lahore, Pakistan. *Atmospheric Environment* 30, 4031-4040.

Sörme, L., Bergbäck, B., Lohm, U., (2001) Goods in the Anthroposphere as a Metal Emission Source A Case Study of Stockholm, Sweden. Water, Air, & Soil Pollution: Focus Volume 1 (Issue 3-4), 213-227.

Stone Elizabeth A., Schauer James J., Quraishi, Tauseef A., Mahmood, A. (2010). Chemical Characterization and Source Apportionment of Fine and Coarse Particulate Matter in Lahore, Pakistan. Atmospheric Environment, 44, 1062-1070.

Tsai, Y. I. and Chen, C. L. (2006). Atmospheric aerosol composition and source apportionments to aerosol in southern Taiwan. Atmospheric Environment 40, 4751–4763.

US-NAAQS (2012). National Ambient Air Quality Standards.

Valipour, M., Mousavi, S. M., Valipour, R., Rezaei, E., (2013). A New Approach for Environmental Crises and its Solutions by Computer Modeling. In: The 1st International Conference on Environmental Crises and its Solutions, Kish Island, Iran.

[a]Valipour, M., (2012). Comparison of Surface Irrigation Simulation Models: Full Hydrodynamic, Zero Inertia, Kinematic Wave. Journal of Agricultural Science 4: 68-74.

[b]Valipour, M., (2012) Ability of Box-Jenkins Models to Estimate of Reference Potential Evapotranspiration (A Case Study: Mehrabad Synoptic Station, Tehran, Iran). IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) 1: 1-11.

Valipour, M., (2012) Determining possible optimal values of required flow, nozzle diameter, and wetted area for linear traveling laterals. The International Journal of Engineering and Science (IJES) 1: 37-43.

Valipour, M., Mousavi, S. M., Valipour, R., Rezaei, E., (2012) Air, Water, and Soil Pollution Study in Industrial Units Using Environmental Flow Diagram. Journal of Basic and Applied Scientific Research. 2: 12365-12372.

Waheed, S., Rahman, A., Daud, M., Rahman, S., Islam, Z., Ahmad, S., (2005) Air quality evaluation of some industrial cities of Pakistan using INAA and AAS. Radiochimica Acta, 93, 487–495

Waheed, S., Rahman, A., Khalid, N., Ahmad, S., (2006). Assessment of air quality of two metropolitan cities in Pakistan: elemental analysis using INAA and AAS. Radiochimica Acta 94:161–166.

Wang Gehui, Huang Liming, Gao Shixiang, Gao Songting, Wang Liansheng (2002). Measurements of PM10 and PM2.5 in urban area ofNanjing, China and the assessment of pulmonarydeposition of particle mass. Chemosphere, 48, 689–695.

WHO (1984). Urban air pollution 1973–1980. World Health Organisation, Geneva.

WHO-AAQS (2011). World Health Organisation Ambient Air Quality Standards, Geneva.

Zhang, Y., Quraishi, T. A. and Schauer, J., (2008). Daily Variations in Sources of Carbonaceous Aerosol in Lahore, Pakistan during a High Pollution Spring Episode, Aerosol and Air Quality Research, 8, 130-146.

Brief Resume of Dr. Muhammad Attique Khan Shahid

As for as my brief resume is concerned I have received my M.Phil Degree in Solid State Physics from CSSP (PU) Lahore Pakistan with research project entitled "**Radioactive Pollution and its Health Hazards, a Study by SSNTDs and XRD analysis"**and Master Degree in Physics with specialization in "**Advance Electronics**" from G.T.I.College (new Campus) Rabwah, affiliated with PU, Lahore. Recently has completed my PhD Degree with project in Solid State Physics entitled "**A Comprehensive Investigation of Solid Aerosols Using XRD and ASS Techniques"**. I have completed other relevant Post graduate training courses as participant, presenter and as a faculty member in my areas of specialization from PINUM, NIAB, PNRA, NIFA, EPD etc the well reputed institutions of Pakistan Atomic Energy Commission and Environmental Protection Department along with my Professional in service training. Recently I am working as Associate Professor of Physics in the Department of Physics GCU (UDC/CC) Faisalabad. As for as my research Experience is concerned it is multidimensional, I have more than 30 years of academic and research experiences at graduation and post graduation level, my areas of interest are Solid state Physics, Surface Physics, Aerosol Physics, Thin Film Technology, Crystal Growth, Cloud Nucleation Theory, Nano Physics Atomic and Nuclear Physics, Health and Medical Physics, Radiation Physics, Radiography and Medical Imaging Geo Physics, Soil Physics, Climatology and Meteorology, X-ray Crystallography etc. More than 95 research Project have been completed under my supervision with breakup as Atomic and Environmental Physics (33), Health and Medical Physics (12), Radiation Physics and Dosimetry (33), Solid State Physics " Electronics and Electrical Instrumentation (09), Soil and Geo Physics (05), Laser and Plasma Physics (03) respectively and have 70 research publications along with 20 manuscripts are in progress and expected to be published very soon in well reputed journals in my credit, Ex. Pakistan Nuclear Regularity Authority (PNRA) certified Health Physicist RPO, RSO (PAEC) as attachment with atomic and Nuclear Physics research lab. Active member of Editorial Committee and reviewer/ referee in above said areas of interest for the Journal of Basic and Applied Sciences (JBAS). Recently working as Executive Editor (Physics Section) for the Journal of Basic and Applied Sciences (JBAS), Associate Editor for journal of Basic and Applied and Scientific research, Editor Peak Journal of Medicine and Medical Science (PJMMS), Editor Peak Journal of Physical and Environmental Science Research (PJPESR), Editor for online journal of Physical and Environmental Science Research (OJPESR), Associate Editor of Peak Journal Public Health and Management (PJPHM) along with member editorial board for the journal of Applied Environmental and Biological Sciences, Global Advanced Research Journal of Geology and Mining Research (GAJMR), International Journal of Chemistry and Material Science, International Journal of Physical Sciences (IJPS), International Journal of Medicine and Medical Science Research (IJMMSR) and member editorial/ advisory board for International Journal of Environmental Science, management and engineering, for International Journal of Environmental science technology and engineering Research, Member technical review board panel for (IJESTER) International journal of informative and futuristic research (IJIFR), Member Editorial/ Associate Advisory board for journal of applicable chemistry (JOAC) etc. I have also worked as an Associate Editor for the journal of Natural Sciences, GCU Faisalabad. Author of Hand book of Physics (9th, 10th) objective type/ subjective type, objective and subjective Physics along with up to date notes for F.Sc (Part I, II), Experimental Physics Manuals (F.Sc part I, II), every day science for all competitive examinations like CSS, PCS etc, M.A Punjabi guides (Complete set) and supervised the Book on "The Secret of Gravity in the Light Of Quran and Science". Member of PIP, Aerosol Physics society and PASTIC. Established and upgraded graduation, post graduation level labs in the department of Physics GCU Faisalabad, played key role in launching B.S (H), M.Sc Physics and M.Phil Physics programs, rectified loopholes in their curriculum as chairman department of Physics through BOS, BOF and academic council meetings to bring them at par with other national/ international universities of the world. I also have very strong management and administrative background being the pioneer of R&D culture at department of Physics GCU Faisalabad, worked as Chairperson Department of Physics, Chairperson academy of letters for sciences, Chairperson Curriculum Revision Committee (CRC), Project Director for Space Sciences, Health and Medical Physics and Telecommunication, Prof in charge SAAP, Atomic and Nuclear Physics Lab, Atmospheric and Environmental Physics Lab, Health and Medical Physics Lab. Currently working as regular faculty member NIAB for graduate, post graduate level courses for atomic energy

commission's scientists working in different organizations along with R and D activities in my areas of interest since 1994 to 1998 as technical expert while fro 1999 to up till now as consultant and regular faculty member and contributing a lot for scientific community through open talks, healthy discussion, lab demonstration and contributing a lot for scientific community through open talks, healthy discussion, lab demonstrations and lecture cum presentations as a resource person in their training courses as joint venture with PINUM, NOORI, NIAB, SKCH etc. in this way high official, technical and non technical staff members of all most all the institutions of Pakistan Atomic Energy Commission working with radiations and safety measures along with relevant departments of Graduate and Post Graduate Male and female (both) colleges and Universities are indirectly benefiting from me and my department. I feel proud to mention above said contributions being the only one University/ College professor's community and record holder of Pakistan Atomic Energy Commission at Graduate and Post Graduate level courses. Internship of B.Sc (Hon) and M.Sc Physics students in Radiation and Health Medical Physics related disciplines are the additional privilege of services rendered by me for the scientific community as joint venture with NIAB. The above said R&D experience resulted in the creation of a team of Physicists and young scientists not only serving the parent department but also enjoying leading positions in various academic institutions and research organizations throughout Pakistan and Modern World. It is my ultimate desire to motivate young Physicists, scholars and scientists to achieve academic excellence in higher education in active areas of Physics which is the need of the day for national up gradation through individual and institutional growth.

I hope the said brief resume along with my recent photograph will meet the pre requisite demand for your kind consideration.

Hoping the best from your side very soon.