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# Perception of Port Harcourt Residents on Governments' Interventions towards Air Quality: The Implication for Air Pollution Policy Accountability Framework

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**Abstract:** ***Globally, air pollution continues to constitute a major environmental and health risk to inhabitants. The geometric rise in population, industrialization and urbanization, especially in urban centres of developing countries, calls for more research and development in the field of air pollution accountability, policy and regulatory assessments. A descriptive cross-sectional survey designed to assess the perception of Port Harcourt residents on Governments' interventions towards air quality was carried out using the convenience/purposive sampling methods. Data was collected from 362 respondents using self-administered questionnaire and analysed using the Statistical Package for the Social Sciences (SPSS) statistical software, version 26.0.Over two-third of the respondents self-rated the abundance of vegetation in their area between low (48.6%, n=176) and very low (20.2%, n=73). Only 5 (1.4%) of the respondents reported having air quality monitoring station or gadget in their area, neighbourhood, work place, school or place of worship. Over three-quarter of the respondents rated government's policy towards air pollution mitigation as poor (36.2%; n=131) and very poor (48.3%; n=175). Also, 353 (97.5%) of the respondents, desired to have "access to clean air" enshrined in States' laws as fundamental human right. Air quality accountability and regulatory framework and legislations such as clean air act, hinged on technologies targeted at preventing emissions, and contextual strategies, systematic routine air quality monitoring, collaboration between public health and environment agencies and consistent communication and participation of citizens are necessary, especially in air polluted cities such as Port Harcourt metropolis.***

**Keywords:** Air Quality, Accountability Framework, Air pollution, Port Harcourt

## 1. Introduction

The field of air pollution accountability, policy and regulatory assessments is observably growing slowly [1, 2] while globally, air pollution continues to constitute a major environmental and health risk to inhabitants [3-5] as more than 80% of urban dwellers are exposed to air quality levels that exceed WHO threshold [6]. Poor air quality resulting from pollution of the atmosphere has been implicated with environmental damages and worsening of the negative impacts of climate change [7]. Consequently, correlations between exposure to poor air quality and plausible increase in populations' burden of cardiopulmonary dysfunctions, increased hospitalization, cancers and other systemic and reproductive morbidity and mortality as well as reduction in life expectancy in both children and adults have all been demonstrated by plethora of epidemiological studies [8 -16], with air pollution accounting for over 7 million annual deaths across the world [6].

Air pollution accountability framework is defined as a series of measures that include the regulation of interest/policy, state of air/quality, exposure/dose/content of inhaled air, and health outcomes on exposed inhabitants [1, 2]. Shutting down of cities by Governments of Nations across the world was observably instituted as one of the necessary public health measures for curtailing the COVID-19 pandemic infection [17]. Though noted as classical method or short term measure [2], such regulatory measures demonstrated the impact of policy on environmental gains, especially as most cities recorded significant reduction in ambient air pollution and improvement of inhaled air pollutants [18, 19]. Socioeconomic activities of humans are inseparable from the environment and in the long term, urbanization and industrial activities aimed at improving the living conditions of the constant growing population and the growth of the global economy, are affecting air quality [20], hence the need for development of air pollution accountability framework. Especially direct policy decisions, regulations, legislations and protocols implemented over longer time and larger spatial scales [2] remains essential for curbing emissions and subsequently protect human health and environment [21 -23] that allows bearable limit of ambient air contamination and continuous balanced industrialization, urbanization and economic prosperity for all [24, 25]. Implicatively, successful air pollution accountability

framework should address effects of regulatory actions and interventions on emissions, air quality, dose and exposure health outcomes [2]as well as the inhabitants' perception and participation [7].

Air quality is said to be the levels of pollutants in the atmosphere of a geographical location and in comparison with permissible thresholds established by regulations or protocols [4, 20]. Poor air quality results mostly from airborne particulates emitted from incomplete combustion of fossil fuels and biomass (see Table 1) from anthropogenic activities remain the most significant source of air pollution globally [26, 27]. Despite significant improvements in developing nations like UK, urban air pollution levels in low-and middle-income countries such as Nigeria (Figure 3) continues to be on the high side, with annual mean levels often exceeding 5-10 times WHO standard [6] and high disease and death burdens [28]. Except for Abuja [29, 30], most cities in Nigeria were found to record 30 times more than WHO's recommended levels of $PM_{10}$ [6]. This is notably worst in settlements where hydrocarbon related industries are prevalent [31] like Port Harcourt [27, 32, 33]. Such places experience black carbon emission over the years, with urban airborne particulates rising at an alarming rate of over 440$\mu gm^{-3}$andwreaking havoc on inhabitants' health [32, 34].

**Table 1:** Criteria air pollutants and sources

| Pollutant | Sources | More Information |
|---|---|---|
| Particulate matter (PM) | Vehicular emissions (including exhaust fumes and tyre and brake wear), household combustion, industrial processes and combustions, construction and demolition, gas flaring, artisanal refining, open burnings of waste, etc. | Airborne particulates with aerodynamic size of less than 2.5 and 10 (PM2.5 and PM10) are stated be harmful to health. |
| Nitrogen Oxides (NOx) | Transportation, combustions and gas flaring from oil explorations | NOx is the umbrella term for nitrogen oxides most relevant to air pollution, including nitrogen dioxide (NO2) and nitric oxide (NO) |
| Sulphur Dioxide (SO2 ) | Transportation, combustions and oil explorations activities | |
| Carbon Monoxide (CO) | Transport (especially petrol-based), combustion and industry | |
| Volatile Organic Compounds (VOCs) | Various sources including transport and combustion. | VOCs are organic compounds which evaporate easily and react with other substances in the sunlight. |
| Ozone (O3 | | Under sunlight Volatile Organic Compounds (VOCs), hydrocarbons and NOx reacts to forms O3 |

Modified and adapted from [4, 35]

Studies have attributed the relative decline in ambient air pollution recorded across Europe, US and other industrialized nations to the implementation of effective air quality accountability framework using updated regulations [5, 7, 36, 37] entrenched on routine scientific monitory, and evidence-based data [38], and technology [4], and communication as well as participation of the people [7]. Notwithstanding evidence of increase in air pollution levels, morbidity and mortality associated with continuous air pollution in Port Harcourt metropolis [39, 40, 41] and outcry of the residents[42],demanding for specific policy, legislations, interventions that minimizes emissions and regulatory framework targeted at improving air quality and mitigating the hazards of air pollution is yet to be instituted [40, 41].

Most cities with relatively acceptable air quality and decline in air pollution have instituted and use continuous air quality monitoring data, legislations; such as clean air act, regulatory policies and guidelines ranging from good public transport coverage, a good cycle network, and financial incentives for electric vehicle purchase, polluter pay principle, trees and vegetation, air pollution removal technologies, systematic air quality monitoring, local area emission limits, outreaches and peoples' participation, and waste management, etc. [4, 6]. In Nigeria and particularly Port Harcourt city, specific legislations for air quality are absent and existing guidelines are either obsolete, lacking immediate Environs' long term air quality monitoring data, and are narrowed together with oil refining standards, favouring the economy over technologically driven solutions that are not people and sustainability centred [43]. The continuous neglect of effective air quality regulatory and legislative framework is likely to increase records of dementia, respiratory and cardiovascular-related illnesses and deaths [6] in Nigeria and Port Harcourt metropolis (see Figures 3 & 4) and this will double the general health burden with consequences on workforce and the economy [40].

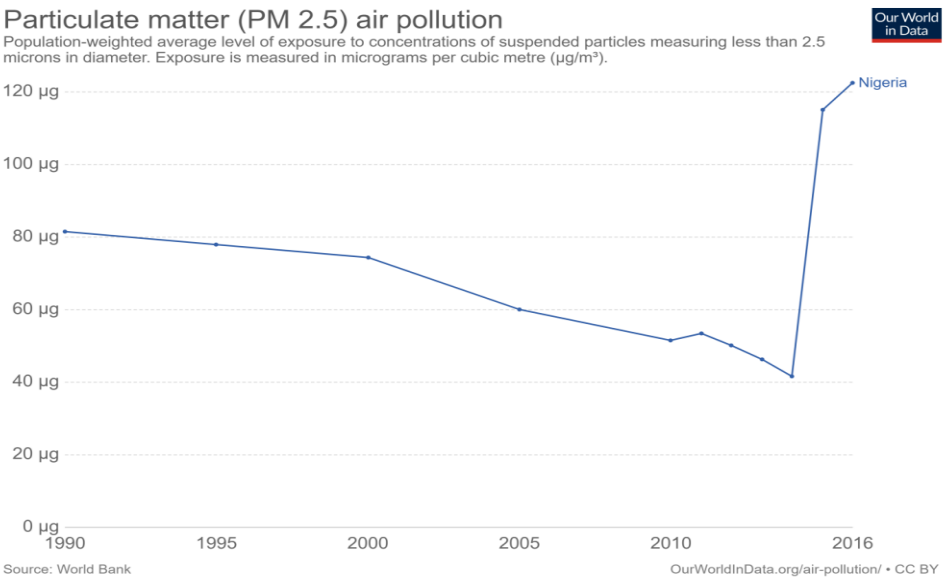


**Figure 2:** Trend of ambient particulate load (air pollution) in Nigeria [44]

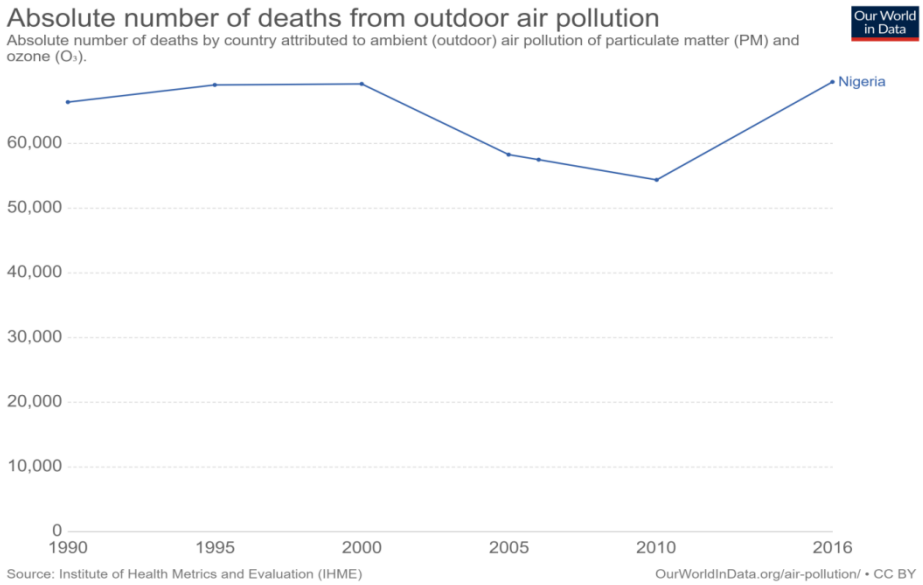


**Figure 3:** Trend in number of deaths from ambient air pollution in Nigeria [44]

Majority of studies carried out on air pollution in Nigeria and Port Harcourt City have only looked at likely health outcomes associated with air pollution, rapid and cross-sectional air quality data of emission levels, content, aerodynamic size and volumes [33, 34, 40 - 42]. Little or no attention have been given to Governments' regulatory, policy and intervention chain of air quality accountability framework, especially that which integrates the participation of residents exposed to air pollution. Given that legislations and policy decisions as well as peoples' behavioural change and perception are at the core of air quality control [4, 12], influencing levels of harmful emissions is mostly dependent on governments' interventions which ranges from updated pollution standards and guidelines, investment in environmental protections, allocation of health resources [12].The essence of this study therefore was to assess the perception of Port Harcourt inhabitants on Governments' interventions towards air quality and examine its implication for air pollution accountability framework.

## 2. Materials and Method

### 2.1 Study design

The research team carried out a descriptive cross-sectional survey designed to assesses the perception of Port Harcourt residents on Governments' interventions towards air quality. This is a variant of survey design that is very suitable for quick knowledge about an issue that may be of public interest.

### 2.2 Study population

The use of smart and connected gadgets is relatively common among residents of Port Harcourt. The research targeted adult inhabitants of Port Harcourt, 20 years and above, who can use and had access to internet incorporated electronic gadgets (phones, PCs, and laptops, etc.).

### 2.3 Sampling method

Convenience/purposive sampling method were used to recruit prospective study participants. Over the years, studies have shown that the ambient air of Port Harcourt had been heavily saturated with air pollutants. Also, prospective exposed participants were at home during the pandemic lockdown and the use of internet-based survey medium necessitated the strategy used for this study.

### 2.4 Sample size

The team estimated the sample size using the formula for estimating sample size for one-sample with proportion, given as: $n = [Z_\alpha^2 (p (1-p)/d^2)]$ were $Z_\alpha = 1.96$ (critical value at 95 confidence interval), $p = 0.62$, $d = 0.05$, $n = 362$. A proportion prevalence (p) of 62% (0.62) was determined using percentage mean estimates from previous studies with similar method and objectives [45 – 48].

### 2.5. Data collection

The study took place between 20th and 28th of May, 2020. To achieve the study objectives, a structured questionnaire was designed to collect responses from participants. The data were collected digitally (through Google form link and distributed to social media groups' platforms via WhatsApps).

### 2.6. Data analysis

Completed responses were downloaded from the Google excel data bases into the Microsoft Excel Spread Sheet (2016), and later exported to the Statistical Package for the Social Sciences (SPSS) software, version 26.0 for analysis. Descriptive analysis (of frequency, mean and standard deviation) was used to describe the responses of study participants.

## 3. Results

### 3.1 Demographic Characteristics of Respondents

A total of 362 respondents completed the questionnaire online. The age of the respondents ranged between 20 and 80 years. More than half (58.0%) of the respondents were between 30 and 39 years, the average age of respondents was 38.9 years and the standard deviation was 7.9 years. Majority of the respondents were male (65.7%) and married (55.8%). The respondents were of varying occupations, but the three most common groups were public servants (20.2%), academics (16.9%) and health workers (14.6%). See Table 2.

**Table 2:** Socio-demographic Characteristics of Respondents

| | *Frequency (n=362)* | *Percentage* |
|---|---|---|
| **Gender** | | |
| Male | 238 | 65.7 |
| Female | 124 | 34.3 |
| **Age cohort (years)** | | |
| 20-29 | 37 | 10.2 |
| 30-39 | 210 | 58.0 |
| 40-49 | 77 | 21.3 |
| 50-59 | 31 | 8.6 |
| ≥60 | 7 | 1.9 |
| **Mean age ± SD (years)** | 38.9±7.9 | |
| **Marital Status** | | |
| Single | 146 | 40.3 |
| Married | 202 | 55.8 |
| Separated/Divorced | 11 | 3.0 |
| Widowed | 3 | 0.8 |
| **Occupation** | | |
| Health Worker | 53 | 14.6 |
| Civil Servant | 27 | 7.5 |
| Academic | 61 | 16.9 |
| Public Servant | 73 | 20.2 |
| Security Agent | 5 | 1.4 |
| Student | 28 | 7.7 |
| Clergy | 3 | 0.8 |
| Small Scale Business | 43 | 11.9 |
| Unemployed/Job Seeker | 19 | 5.2 |
| Entertainer | 8 | 2.2 |
| Others | 42 | 11.6 |

### 3.2 Perception of Government's Policies and Interventions toward Air Quality

Over two-third of the respondents self-rated the abundance of vegetation in their area between low (48.6%; n=176) and very low (20.2%; n=73) (Figure 4). Only 5 (1.4%) of the respondents reported having air quality monitoring station or gadget in their area, neighbourhood, work place, school or place of worship (Figure 5). Over three-quarter of the respondents reported that government's policy regarding air pollution was between poor (36.2%; n=131) and very poor (48.3%; n=171) (Figure 6). About 353 (97.5%) of the respondents desired to have "access to clean air" enshrined in the States' laws as one of the fundamental human rights (Figure 7).

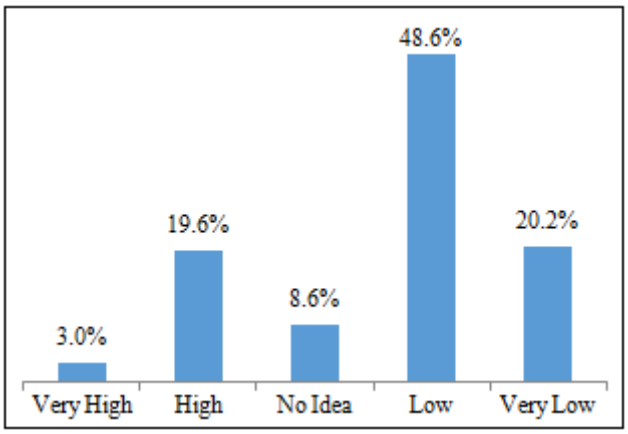


**Figure 4:** Residents' rating of abundance of vegetation in residential areas of Port Harcourt

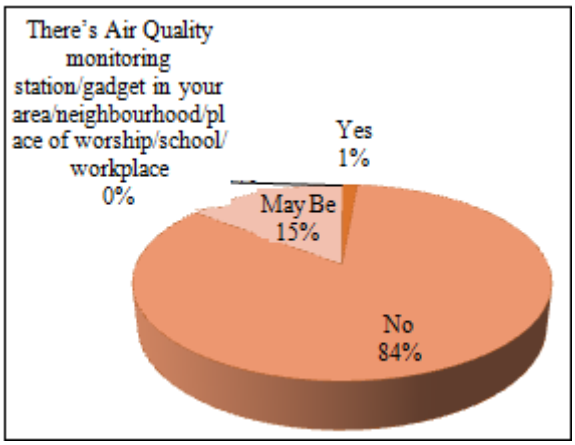


**Figure 5:** Awareness Presence of Air Quality Monitoring Gadgets among Respondents

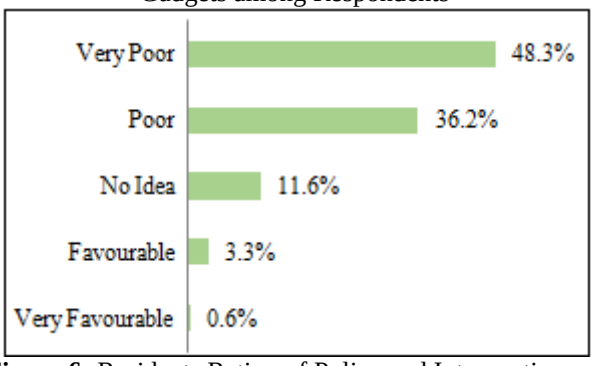


**Figure 6:** Residents Rating of Policy and Interventions of Governments on Air Quality

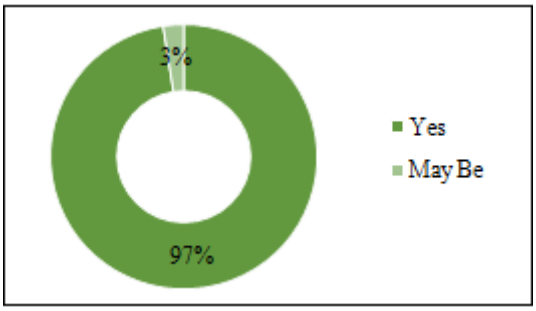


**Figure 7:** Residents' desire to having "access to clean air" as Right Enshrined in States' Laws

## 4. Discussion

Over the years, the World Trade Organization (WTO) agreement, Generalized Special Preferences (GSP), and the Global Value Chain (GVC) have all encouraged industrialization across cities such as Port Harcourt in developing countries where low-cost manpower and institutional flexibility[49]and weak environmental accountability framework[2, 7]were available. Both labour demanding and polluting industries have been noted to relocate to these countries [50].Hence, the city of Port Harcourt, like most other cities in developing countries have witness benefits in development in the form of industrialization [49, 51] especially from petroleum activities with resultants health burdens and ecological effects in the form of soot haze and air pollution generally [40, 42, 46].

The poor air quality noted across cities in developing countries poses public health and environment concerns [6], as children, infants, pregnant women, the elderly and outdoor workers continues tobe vulnerable, with increase in morbidity and mortality outcomes, especially from criteria air pollutant such as particulate matter [6,39, 52]. The industrial ecology and economy of Nigeria, specifically the city of Port Harcourt is driven by petroleum and hydrocarbon activities, hence the increase in burden of poor air quality [34, 40-42]and its resultants health effects on residents [39, 40]. It is on this premise that this study assessed the sensitivity of Port Harcourt residents on Government policies towards air quality that affects their daily lives. It is believed that findings from this study will impact on air pollution accountability framework of Governments, using appropriate technological and evidence-based policy intervention structure to mitigate the prevailing black carbon emission within and around Port Harcourt metropolis.

The importance of trees and vegetation in air pollution mitigation has been demonstrated [53],hence respondents' low rating of availability of trees and vegetation across Port Harcourt residential areas could explain the severity of black carbon experienced [39 -40], as trees are found to cushion the effect of ambient particulates and air pollution generally [54, 55]. In a densely populated setting like Port Harcourt, trees could improve air quality by filtering out, trapping and dissipating air pollutants [56-58].

For air pollution mitigation, trees matters [4], hence the application of optimal planting method for air pollution control benefit using planting "priority index" map which categories locations according to localised pollution loads, population density and existing tree cover [59]. Trees differs in their effectiveness for use in air pollution control, with conifers demonstrating higher ability in capturing pollution than broad leaved trees species [60, 61] which consequently improves local air quality. The benefits of tress on air pollution have necessitated advocacies such as Million Tree Initiative, urban greening initiatives [62, 63].A 10µgm$^{-3}$increase in fine particulate matter exposure has been linked with about 4%, 6%, and 8% increased risk in all-cause, cardio- pulmonary and lung cancer mortality respectively [64] and reduction in life expectance by 0.64 years [65]. Tree planting initiatives and policy is likely to benefit residents of Port Harcourt both in life expectancy increase and reduction in burden of morbidity and mortality associated with poor air quality [16, 55, 60]. Trees have been found to remove about 4.7 to 64.5 tonnes of $PM_{2.5}$ in Cities of US and improving air quality by 0.05% to 0.24%, annually with resultant mortality reductions of approximately 1 to 8 people per year across the city studied [55].

In some cities in the Mid-lands of UK, studies have demonstrated that increase in total tree cover from 3.7% to 16.5% decreased average primary $PM_{10}$ load by 10% from 2.3 to 2.1µgm$^3$, while in Glasgow, increasing tree cover from 3.6% to 8% was stated to reduce $PM_{10}$ load by 2% [66]. In the Greater London area (UK), annually, urban tree shades were projected to remove between 852 and 2121 tonnes of$PM_{10}$, equating to about 0.7% to 1.4% $PM_{10}$ air quality improvement [67]. With increase in trend of mortality and children hospitalization associated with black carbon emission in Port Harcourt metropolis [39, 40], strategic tree

planting is likely to avert deaths due to air pollution exposures. This was demonstrated by Tiwary *et al.* [68] in which a 10 by 10 km grid in London with 25% tree cover was estimated to take away 90.4 tonnes of$PM_{10}$ per year, resulting to the avoidance of 2 deaths and 2 hospital emissions per year [55, 68].

Lack of air quality monitoring stations and gadgets at strategic places could contribute to poor Government's policies towards air pollution mitigation [4, 26]. This present study showed that most of the respondents have not seen or heard of the availability of air quality monitoring station or gadget in any strategic location in Port Harcourt metropolis. When available, routine communication of monitored local area air quality has been recommended, as it is the citizens' right to be informed about unsafe air quality [7]. Most cities in developing countries do not have a systematic system of air quality monitoring. Hence the lack of air quality data undermines efforts in evaluating the effectiveness of air quality initiatives [4, 69, 70]. Also, the need for an expanded and improved national and regional air quality monitoring networks as fundamental prerequisite for improving air quality have been established [20, 69-71]. In addition, public access to local real time daily air quality data have been demonstrated in some cities in UK, China and US using smartphone apps that incorporate such data in improving daily urban life [72].

The concern of citizens over lack of routine air quality data should be a priority for the authorities. However one-shot rapid monitoring gives little evidence of air pollution impacts and cannot be strongly associated with trends of health record outcomes in the form of mortality and morbidity [40, 41]. Unlike times series air quality data and deterministic air quality models that directly estimate the impacts of emissions on ambient air quality, making it possible to differentiate the effects of multiple regulations occurring simultaneously through the estimation of emission-concentration sensitivities [2,5, 7, 37, 38] and are primary tools used to assess proposed regulations [2].

Majority of residents reported unfavourable disposition towards government intervention and policies towards air pollution in the city. This agrees with reports of poor government's spending to preserve and protect the environment [6, 70]. Across the world different air quality and pollution management strategies and technologies have been deployed. The strategies were found to range from policy and regulatory frameworks legislation or soft power, sanctions, guideline and standards, and taxation or levies available to governments and as well as funding air pollution mitigation initiatives and research. The technologies are either targeted at preventing emissions or retrospectively remove emissions from the ambient air [4, 73]. Strategies such as restriction of emission sources using low emission zones (LEZ) regulations [74-79], encouraging private vehicle behavioural change in urban settings [80, 81] for cycling and other low emission transport sources [82-91], speed management as lower speed limits could be cost-effective in impacting air quality near roads [92-97] and outreach strategies that increase public awareness and citizens participations in air pollution control have also been documented [35, 91, 98, 99]. The technologies deployed for ambient air pollution control most often removes existing pollution in a place [97, 100,101]. They include switching to less polluting [102-107], roadside barriers[57, 108-109], trees and vegetation [4, 55, 110-112], air quality monitoring [2, 4, 6] and modular refinery [40]. Adapting and contextualizing these measures targeted at reducing the black carbon emission in Port Harcourt will decrease the resultant health burdens associated with it.

Over 90% of respondents desired for "access to clean air" enshrined in States' laws as fundamental right. Laws such as "access to clean air act" by government have the potential of enhancing air pollution mitigation measures and health burden [111]. Clean Air Act regulations in some parts of the world was stated to have prevented over 205,000 premature deaths and millions of other non-fatal illnesses, as well as prevent severe cardiac and respiratory diseases, and when economically expressed, the benefit was estimated as $50 trillion [112]. It is also projected that by 2020, the US could gain more than $2 trillion in health savings as amended clean air act is likely to avert 2.4 million asthma exacerbations, 135,000 hospital admissions, and over 230,000 premature deaths [113, 114]. Investment in environmental protection, especially air pollution mitigation policies and legislations in developing countries and air polluted cities should be encouraged [4, 7, 15, 24, 115-117].

There were some limitations for this survey. Firstly, this survey was rapidly conducted within the pandemic lockdown days in Port Harcourt and was done online. Secondly, the survey participants were limited to those with internet supporting devices. Residents with no such devices may have expressed different perception. Thirdly, the survey questionnaire contained little (or no) questions relating to residents' practices.

## 5. Conclusion and Recommendations

The lack of air quality monitoring stations, poor vegetation cover and poor rating of governments' intervention and policies towards air pollution by residents and desire for specific air quality legislations implicates the concerns of previous researches and international protocols [2, 4, 7]. The health and ecological burden of air pollution remains a global concern [5, 26, 36]. An institutionalised air quality accountability framework hinged on technology, contextual strategies, systematic routine air quality monitoring, collaboration between public health and environment agencies, consistent communication and participation of citizens are necessary, especially in developing countries with air polluted cities such as Port Harcourt.

## 6. Abbreviation

EPA: Environmental Protection Agency
RSMENV: Rivers State Ministry of Environment
WHO: World Health Organization

## 7. Funding

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## 8. Competing interests

The authors declare that they have no competing interests.

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