Urban Congestion and Pollution: A Quest for Cogent Solutions for Accra City

Baba Imoro Musah1,*, Lai Peng1 and Yifeng Xu1

1 Department of Environmental Science and Engineering, School of Resources and Environmental Engineering, Wuhan University of Technology, Luoshi Road No. 122, Hongshan, Wuhan, Hubei, 430070, PR China

* babamusah94@yahoo.com

Abstract. Transportation plays instrumental role in the socio-economic development. Road transport is such vital sector which contributes significantly to the growth of many economies. Efficient, affordable, reliable and safe transport system is the most desirable and suitable form of transportation system required to facilitate development. Accra, the capital city of Ghana in West Africa is engulfed with traffic congestion. Accra has the highest motorization rate in the entire country, however, road infrastructure in the city is woefully inadequate. Rapid population growth attributable to rural-urban migration has exacerbated the demand for transportation services. The city contributes a quarter of the total gross domestic product of Ghana and attracts overwhelming 83% of all direct foreign investments (DFI) in the whole country. The projected population growth is 2.4% per annum from 2016 to 2030, a rise from the 2.0% between 2000 to 2016. Carbon dioxide emissions increased by a whopping 285.71% between 1990 to 2012. Annual mean particulate matter (PM$_{2.5}$) $\mu$g m$^{-3}$ score for Accra is 31.1 $\mu$g m$^{-3}$. Nearly 3000 deaths are recorded annually in Accra attributable to outdoor air pollution related ailments. Traffic congestion in Accra could be significantly reduced through array of potential solutions such as transportation sector policy reforms to incorporate smart and intelligent transportation systems, expansion of road network through adequate investment in infrastructure, strict compliance and enforcement of traffic regulations.

1. Introduction

The desire by many people to live in cities around the world is fascinating. In a recent study by [1], the importance of cities regarding human development has been outlined.

Similarly, research has revealed the upsurge of rural-urban migration with a proportional growth of 45% from 5% in the last two centuries globally [2]. In 2008, over half of the world’s population, 3.3 billion people were living in urban areas. It is expected to hit 4.9 billion people by 2030. The urban populations of both Africa and Asia will be doubled in a period of 30 years thus from 2000 to 2030 [3].

This proportional growth in the next 32 years is projected to rise to about 66%, with developing countries suffering most [4]. A study conducted by [5] revealed that rapid urbanization is not synonymous with improved living conditions of the people. The reverse of improved living conditions is the case of developing countries where rapid urbanization exists. In Africa, population in urban areas collectively is estimated to be 472 million people and further expected to double in the next 25 years due to surge in rural-urban migration with continental urban population growth rate estimated to be 4% annually [6].
In West Africa, out of an estimated total population of 178,364,333 people, 46.7% of people in West Africa are said to be living in urban areas (http://www.worldometers.info/world-population/western-africa-population/). The rapid population growth in cities are associated with increasing demand for use and ownership of motor vehicles ranging from personal vehicles in developed economies to mini buses in developing countries [7]. Transportation is a key demand in human life but however it is associated with many issues such as traffic jams or congestions, accidents and exposure to many respiratory infections due air pollution. The greatest source of air pollution in urban areas is attributable to motor transportation with extreme exposure levels [8]. The level of traffic congestion in Accra is getting from bad to worse by each passing year. The high urban population growth rate of 4.2% continue to worsen the situation coupled with increasing growth in vehicle ownership. Key roads in Accra, 70% of them are classified as congested with vehicle speed levels hovering around 20 km/hr and could even get lower if present trends continues [9]. This study seeks to go beyond mere identification and highlighting of the existing challenges to proffering potential but concrete strategies to help ameliorate the situation.

A brief overview of Ghana’s transportation infrastructure, state of traffic congestion in Accra and plausible strategies. At the end the research, answers to the following questions would be answered:

1. What is the average age of vehicles imported?
2. What is the extent of outdoor air pollution in Accra and its impact on public health?
3. What is the quality vis-à-vis quantity of fossil fuels used in Accra?
4. What strategies could be employed to effectively and efficiently mitigate traffic congestion?

2. Transportation system in Ghana

The most common form of transportation in Ghana is land thus roads and highways which are largely dependent on fossil fuel. Air transportation (aviation) and rail transportation (railways) both represent microscopic proportion due to the fact that, overwhelming majority of people do not patronize these means of transport. This is either due to their complete unavailability or high cost of fares charged by the few existing ones. As a result, there is eminent pressure on road transport, private sector operatives have taken undue advantage of the situation to provide ‘public’ bus and mini vans known in local language as ‘tro-tro’ services mostly in urban areas. Many of these private mini-buses are imported as second-hand vehicles and which are poorly maintained eventually, giving rise to high incidence vehicular emissions. This is reflected in a report by United Nations Environment Programme (UNEP) which attributed bulky portion of Ghana’s Green House Gases (GHGs) emissions to transport sector [10]. Though governments over the years have made certain interventions in this sector leading to a growth in transportation infrastructure by 8.1% between 2001 to 2012, this is woefully inadequate [11]. Without any effective and reliable interventions to mitigate the negative impacts of air pollution, an ever-growing city population will obviously come with high vehicle ownership and its associated consequences. Traffic congestion has far reaching negative effects in terms of lives, economic, environmental, and social cost. The negative repercussion of congestion is not just limited to drain on the economy but loss of precious lives. When vehicles’ urban traffic speed are decelerated by half, it brings about 50% rise in NOx emissions from bigger vehicles [12].

The World Health Organization defines clean air per its air quality guidelines value for particulate matter (PM$_{10}$) as 10 μg m$^{-3}$ annual mean (a/m) and 25 μg m$^{-3}$ 24-hour mean (h/m). For PM$_{10}$, it is 20 μg m$^{-3}$ a/m and 50 μg m$^{-3}$ 24-h/m. Ozone (O$_3$) is 100 μg m$^{-3}$ 8-h/m, Sulfur dioxide (SO$_2$) 20 μg m$^{-3}$ 24-h/m and 500 μg m$^{-3}$ 10-minute mean (m/m). While the value for Nitrogen dioxide (NO$_2$) is 40 μg m$^{-3}$ a/m and 200 μg m$^{-3}$ 1-h/m [13]. Road transport is the dominant mode of transportation in Ghana accounting for about 95% of passenger traffic movement and 98% for freight movement [14]. Long waiting in queues by commuters due to traffic jams in Accra is a key reason many people do not consider bus routes to be convenient means of mobility [15]. “In our part of the world, air pollution is not prioritized as a health concern. But the statistics are so staggering that we have to wake people up to take action. We have to talk about it loudly so that it becomes part of our discourse in the urban political space” Mayor of Accra, Mohammed Adjei Sowah, 20 August 2018 (http://ccacoalition.org/en/news/accraghana-first-african-city-join-breathelife-campaign). The number of deaths annually due to air pollution
are 6,500 people in Ghana according WHO. (https://www.ghanaweb.com/GhanaHomePage/health/6-500-Ghanaians-die-annually-due-to-exposure-to-air-pollution-WHO-254424).

3. Accra in perspective

Accra has an estimated population of 1,848,614 representing 46.1% of the total population of Greater Accra Region which stood at 4,010,054. The breakdown in terms of male-female ratio is 887,673 and 960,941 respectively [16]. It has an area of 137 km² located in the Greater Accra Region, one of the 16 administrative regions with total regional area of 3, 245 km² [17]. The city had average annual population growth rate of 2% between 2000 to 2016 but it is projected to reach 2.4% between 2016 to 2030. In terms of urban and national population, it is 15.4% and 8.4% respectively [18]. The city is recently ranked among the five busiest cities in Africa (https://www.africa.com/2018). Accra serves as Ghana’s economic backbone producing a quarter of Ghana’s gross domestic products and attracts overwhelming 83% of all direct foreign investments in the country [19]. Accra was ranked 13th and 207th among cities that attracted Foreign Direct Investments (FDIs) at continental and global levels respectively with a growth of 34.7% between 2003 to 2016 [20].

Traffic congestion in Accra is a nightmare to commuters and other road users on daily basis especially on many of the trunk roads. The total road networks are 1,632 kilometres with 1,310 being tarred roads https://www.modernghana.com/news/363365/go-slow-in-accra-horrible-ordeal-for-commuters.html). There are over 2,800 deaths that occur per year due to exposure to Particulate Matter as at 2015 in Accra and it is predicted to rise above 3,000 deaths per year in 2020 and over 4,500 in 2030 if the current trends continue without a drastic action [21]. In 2015, the total number of registered vehicles in Ghana stood approximately at 1,952,564. The Greater Accra Region where Accra is located had the highest number of registered vehicles of 1,164,942. The vehicle/population ratio in Ghana has been growing steadily from about 50 vehicles per 1,000 population in 2010, to about 70 vehicles per 1,000 population in 2015. The average age of a vehicle in Ghana is about 14.2 years old. This is even significantly higher for ‘public’ transport vehicles operated by private transport owners. Majority of vehicles imported are second hand [22]. Figure 1 and figure 2 illustrate 19 years records of registered vehicles and total national fleets.

![Figure 1. Graph illustrating total number of registered vehicles year on year from 1997-2015 in Ghana. Authors’ preparation (data source: DVLA, 2016)](https://example.com/figure1.png)
In the first week of 2017, more vehicles were registered compared to the same period in 2016. Thus 1,960 vehicles were registered in first week of 2017 as against 984 vehicles registered same period in 2016 in Accra only (https://kasapafmonline.com/2017/01/12/vehicles-registered-first-week-2017-2016-dvla/). In just January 2018, a record high of 19,931 vehicles were registered as against 18,401 in 2016 representing 8.31% rise (http://cilthg.org/about-20000-vehicles-registered-in-january/). Between 2005 to 2016, over 1 million vehicles were imported into Ghana and 80% of this fleet were second-hand (used) vehicles according customs. (https://www.graphic.com.gh/news/general-news/over-1-million-vehicles-imported-into-ghana-in-10-years.html). United Nation in 2015 launched 17 Sustainable Development Goals (SDGs) dubbed “AGENDA 2030”, the following individual goals are relevant in the context of this study:

❖ “take urgent action to combat climate change and its impacts” (SDG1 3)
❖ “build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation” (SDG 9) and
❖ “make cities and human settlements inclusive, safe, resilient and sustainable” (SDG 11) [23].

Figure 3 provides details of vehicles types and number that were registered in 2010 and 2015 in Accra.

The total annual average daily traffic stood at 19,432 and 26,233 in Accra for 2010 and 2015 respectively. This represents a total annual average daily traffic increment of 35% in Accra. For instance,
Labone-Nima-Circle (Nkrumah) road, Sankara-37 Military Hospital road, Airport Junction-Accra mall road, Okponglo (Legon)-Madina road, Achimota-Ofankor-amasaman road. Figure 4 gives vivid example:

**Figure 4.** Traffic congestion on Airport-Shiashi-Gulf House road (Authors: Field, Nov. 2018)

4. **High vehicle importation (second-hand)**

Africa is estimated to have 42,510,000 vehicles in use as at 2014 and automotive products imported into Africa amounted to $48 billion in same year. Though, importation of vehicles itself is not necessarily an issue particularly when domestic production is unable to meet local demand or no production at all. Quality however, ought not to be sacrificed for quantity. In 2013, Ghana was one of the top 10 countries in Sub-Saharan Africa that imported 69,247 out of a total of 800,000 second-hand vehicles from abroad e.g Japan, US and EU [25]. The current legal regime regulating the importation of automobiles into Ghana is fraught with many lapses, as a result, vehicle importers take undue advantage of the system. For instance, imported vehicles which are more than 10 years of age but not more than 12 years old are slapped with a paltry fine or penalty of 2.5% in addition to flat 5% and 12.5% for import duty and Value Added Tax (VAT) respectively. Imported vehicles which are more than 12 years old but less than 15 years attract an overage fine or penalty of 10% in addition to the flat import duty and VAT as indicated earlier. Similarly, imported vehicles which are more than 15 years old but not up to 20 years also attract overage fine or penalty of 15% in addition to other flat charges. Imported vehicles which are over 20 years old, attract an overage fine or penalty of 50% in addition to 5% import duty and 12.5% VAT [26]. This policy or legal regime is outmoded, eco-friendly automobile importation regulations are urgently needed. The WHO reported in May 2018, that Ghana’s annual mean level score of Particulate Matter (PM$_{2.5}$) $\mu g m^{-3}$ in Accra and other cities in 2016 was 31.1$\mu g m^{-3}$. This is in excess of 21.1 $\mu g m^{-3}$ compared with WHO standard annual air quality mean value of 10 $\mu g m^{-3}$ [13]. Figure 5 provides an example of ‘poisonous’ exhaust fumes released into the atmosphere from a moving truck.

**Figure 5.** Smoky tipper truck on road in Accra, December 2018 (Credit: Lingani Goodman)

The UNEP in 2014 attributed large chunk GHGs emissions in the country to transportation. This lends credence to a suspicion that the situation could have been occasioned by the influx of ‘dumped’ old vehicles in Accra. Lack of efficient and reliable public transport system in the city opened the
floodgates for private vehicle dominance [10]. In 2015, the Ministry of Environment Science, Technology and Innovation (MESTI) in and the EPA revealed trends of total national greenhouse gas (GHG) emissions which showed upward adjustment from 14.22 Metric tonnes of equivalent Carbon dioxide (MtCO$_2$) to 33.66 MtCO$_2$e in 1990 and 2012 respectively. Emissions due to activities of fuel combustion increased from 3.50MtCO$_2$e in 1990 to 13.50MtCO$_2$e in 2012 representing 285.71% increase. It is intriguing that in 2012, CO$_2$ constituted the largest GHG contributor to national emissions with 44% followed by Nitrous oxide (N$_2$O) 30.08% and Methane (CH$_4$) 24.8%.

5. Energy dynamics (fossil fuel)

The type, quality and quantity of fuel used to power automobiles in Ghana was evaluated in order to make comparison with recommended standards. The entire country is dependent on imported crude oil (fossil fuel) as its main source of energy, so are vehicles in Accra. Ghana’s crude oil imports from 2000 to 2004 exhibited upward trends. Crude oil imports stood at 1,131,834; 1,262,872; 1,179,363; 1,406,205 and 1,813,464 tonnes for the year 2000, 2001, 2002, 2003 and 2004 respectively. Within the same period, total fuel supplied for domestic purpose were 1,555,000; 1,511,282; 1,641,778; 1,636,574 and 1,807,240 tonnes for the year 2000, 2001, 2002, 2003 and 2004 respectively [27]. Further analysis revealed that, from 2000 to 2004, diesel was the largest product used followed by gasoline and the general quality is hovering around 3000 ppm. For instance, Tunisia has 0 to 10 ppm whilst Morocco has 31 to 50 ppm, these provide the lowest Sulfur limits in gasoline. Morocco has the lowest limits of range for diesel from 0 to 15 ppm [28]. Diesel is noted to be a major contributor to vehicular emissions and the second largest source of NO$_x$ [29].

6. Mitigation strategies

6.1 Transportation policy reforms

It has been established that majority of vehicles imported into Ghana are second-hand vehicles with average age of 14.2 years [22]. Other African countries such as Algeria, Chad, Mauritius, Seychelles and Angola banned importation of vehicles which are from 3 years and above. Similarly, Tunisia, Mozambique and Niger have banned importation of ‘used vehicles’ that are 5 years old or above. In Ghana, the current Legislative Instrument (L.I) framework which regulates vehicle emission states “No person shall drive a motor vehicle which emits exhaust fumes in such quantities as to be a hazard or annoyance to road users or pedestrians (Regulation No. 33, L.I. 952, Road Traffic Regulations, 1974)” [26]. There is urgent need for city authorities and central government to ensure holistic transportation sector policy reforms taking into account the exigencies of modern and smart transportation systems.

6.2 Mobility, smart traffic controlling and signaling systems

This basically offers alternative but effective various transport choices to trekkers aim at lessening over reliance on private vehicles. This provides for comprehensive transportation policies taking into account efficiency, effective and judicious use of available resources that can be renewed (http://www.vtpi.org/tdm/2018). This encourages the patronage of alternative means of transport such as bicycles, public buses, trekking rather than opting for private car or vehicle ownership [30].

Addis Ababa city in Ethiopia is a good example to learn from within the continent. The city’s population at 2013 was estimated to be 3.1 million people but with very low motorization rate compared to Accra. In 2012, rate of motorization in Addis Ababa city stood at 65 vehicles per 1000 people with a total vehicle fleet in the city being 196,980 according to World Bank report 2014. In a city where efficient and reliable public transport is lacking, people are left with option resorting to private vehicles [31]. Current traffic control systems rely heavily on obsolete systems dependent on fixed time signals (FTS) rather than automated traffic monitoring and signaling system. Intelligent traffic control system presents an alternative solution or relief to help facilitate traffic management in Accra.
Though the congestion in Accra may have somewhat predicted by previous literature [32], [33], [34], [35], the issue of inadequate road infrastructure is visible now than ever. The street network in length in 2008 was 2,355 km with half (50%) paved while land set aside for the purposes of streets in the urban core is low as 11.1% [17]. Adequate investment in transportation infrastructure is no longer a need but a necessity. Rampant street hawking activities should be curbed. This could ease traffic congestion and also reduce current high incident of fatalities on the roads. For instance Accra recorded 891 fatalities between 2011 and 2015 whilst 8,654 injuries were recorded during the same period [17].

The city is predominantly ‘choked’ with private public transport such as ‘trotro’ (minibuses) which represent 35%, taxi-caps represent 25% whilst large buses represent the remaining 40% [17].

7. Conclusion
Traffic congestion in Accra city is a major issue and it may be attributed to multifaceted factors inadequate road infrastructure, high motorization rate, lack of efficient and reliable public transport. Traffic congestion in Accra has adverse effects ranging from economically to human health or lives. The average age of vehicles in Ghana is a little over 14 years. There are more than 2,800 deaths that occur annually as a result of exposure to particulate matter (PM) in 2015 and the number is projected hit 3,000 deaths per year in 2020. The quality of energy (fossil fuel) available to motorists in Accra and by extension, entire country is largely 3000 ppm or a little below. A downward review is therefore necessary to reduce the sulfur or NOx content respectively. Effective collaboration between city authorities, central government and other relevant stakeholders will help facilitate an introduction and implementation of comprehensive transportation system in Accra. Thus, mobility management, smart traffic signaling and control systems, adequate investment in transportation infrastructure and strict enforcement of traffic regulations in the city. These would effectively and significantly improve current state of congestion in Accra. Smooth flow of traffic will ease movement of goods, services and people which may ultimately boost productivity. Improvement in outdoor air quality in the city will enhance quality of life people in Accra.

Funding
This research did not receive any form of funding or grant from any agency or organization.

References
[1] Riffat S, Powell R and Aydin D 2016 Future cities and environmental sustainability, Futur. Cities Environ., pp. 1–23
[2] Mcmichael A J 2000 The urban environment and health in a world of increasing globalization: issues for developing countries vol. 78.
[3] United Nations 2011 World population prospects the 2010 revision: volume I: comprehensive tables New York.
[4] United Nations Fund for Population Activities 2014 The power of 1.8 billion adolescents, youth and the transformation of the future: state of world population 2014.
[5] Ingwe et al 2008 Sustainable energy technologies for an emerging African megacity, Urban Energy Transit., no. 9780080453415, pp. 631–645.
[6] World Bank Group 2017 Africa’s Cities, opening doors to the world.
[7] Gwilliam K 2013 Cities on the move - ten years after.
[8] RAC Foundation 2014 Air quality and road transport impacts and solutions, no. June.
[9] Agyemang E 2009 Traffic congestion: the bane of a bus rapid transit system in traffic congestion: the bane of a bus rapid transit system in accra, ghana? Master of Philosophy thesis in development studies (specializing in geography) August.
[10] United Nations Environment Programme 2014 Green economy fiscal policy scoping study, Ghana.
[11] Government of Ghana 2013 Highlights of the budget statement and economic policy.
[12] Esposito G 2017 Low emission vehicles & low CVP activities in accelerating the market, Nov.
World Health Organization 2005 Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide.

African Development Fund 2003 Ghana Road Infrastructure Appraisal Report.

Ghana Statistical Service 2012 Republic of ghana ministry of roads and highways transport indicators and database project.

Ghana Statistical Service 2010 Population and housing census, summary report final.

Accra Metropolitan Assembly 2017 pedestrian road safety action plan for the accra metropolitan 2012-2018

United Nations 2016 The world's cities in 2016 data booklet, report, p. 29.

Cities Alliance 2016 Future proofing cities; Ghana - metropolitan cities.

UN-Habit/EUR 2018 The state of african cities.

Environmental Protection Agency 2018 Overview of air quality monitoring in Accra Ghana.

Ministry of Transport 2016 Vehicle population and growth rate.

United Nations 2015 Transforming our world: the 2030 agenda for sustainable development.

World Bank Group 2017 Integrated transport system & land-use planning.

United Nations Environment 2018 Africa used vehicle report.

Driver and Vehicle Licensing Authority 2016 Vehicle emission enforcement.

Energy Commission 2006 Strategic national energy plan 2006 – 2020.

Stratas Advisors 2018 Fuel quality and emission standard developments in Africa.

RAC Foundation 2014 Air quality and road transport impacts and solutions, London.

Goodwin P 1999 Transformation of transport policy in Great Britain, vol. 33, pp. 655–669.

World Health Organization 2000 The urban environment and health in a world of increasing globalization : issues for developing countries, vol. 78.

Abaane A M 1992 Tackling traffic congestion in Accra, Ghana : a road user's perspective, vol. 27, no. 2, pp. 193–206.

Addo S T 2002 Provision of urban transport services in Accra, vol. 8, p. 8.

Frederick et al 2010 A systems dynamics approach to explore traffic congestion and air pollution link in the city of Accra, Ghana, sustainability, no. ISSN 2071-1050, pp. 252–265.

Dionisio et al 2010 Within-neighborhood patterns and sources of particle pollution: mobile monitoring and geographic information system analysis in four communities in Accra, Ghana, Environ. Health Perspect., vol. 118, no. 5, pp. 607–613.

Web sources

1. http://www.worldometers.info/world-population/western-africa-population/ accessed on 19-12-2018 23:24, GMT+8
2. http://ccacoalition.org/en/news/accra-ghana-first-african-city-join-breathelife-campaign/ accessed on 07-12-2018 23:13, GMT+8
3. https://www.ghanaweb.com/GhanaHomePage/health/6-500-Ghanaians-die-annually-due-to-exposure-to-air-pollution-WHO-254424/ accessed on 23-11-2018 03:07, GMT+8
4. https://www.modernghana.com/news/363365/go-slow-in-accra-horrible-ordeal-for-commuters.html accessed on 13-12-2018 13:20, GMT+8
5. https://kasapafmonline.com/2017/01/12/vehicles-registered-first-week-2017-2016-dvla/ accessed on 16-12-2018 16:07, GMT+8
6. http://cilthg.org/about-20000-vehicles-registered-in-january/_accessed on 15-12-2018 18:13, GMT+8
7. https://www.graphic.com.gh/news/general-news/over-1-million-vehicles-imported-into-ghana-in-10-years.html accessed on 15-12-2018 18:03, GMT+8
8. http://www.vtpi.org/tdm/ accessed on 14-01-2019 04:26, GMT+8