CO2 Emissions and Sources: A Comparative Study in Bangladesh

By ***Muammer Galib Mahdi***

Introduction

The problem of CO2 emissions has climbed high up on the governments' agendas across the world. (Baiocchi & Minx, 2010) At present, the world is facing a major problem of global warming due to the rapid increase in carbon emissions (Ahmed et.al., 2020). Global CO2 emission has nearly tripled from 9385.8 million tons to 36,138.3 million tons from 1960 to 2014 (World Bank, 2018). The manufacturing and construction industries are the second largest carbon emitter which consists of nearly 19.96% of CO2 emissions in 2014, after the transportation industry across global countries (World Bank, 2018). CO2 emission in Bangladesh has also increased from 37990 kilotons to 90739.9 kilotons from 2007 to 2019. (World Development Indicator, 2019) According to Rahman & Kashem (2017), the rapid growth of manufacturing and service sectors of Bangladesh usually stems from high consumption of fossil fuels such as coal, crude oil, and natural gas. Crude, refined petroleum oil and natural gas are the prime input of transport sector, electricity producing and manufacturing plants of this country, and there is a close relation between consumption of such fuel inputs and CO2 emissions regardless of the country (Rahman & Kashem, 2017). The power sector is a major contributor to CO2 emissions in Bangladesh, with the majority of electricity being generated from fossil fuels such as natural gas, coal and oil, particularly natural gas, which accounts for around 62.90% of the country's electricity generation (Islam et.al., 2022).

According to the 5th IPCC Review Article, global temperatures should not rise beyond 2 °C by the twenty-first century's end (IPCC 2014). Consequently, the increasing level of CO2 emissions from different sources is one of the key concerns of the country as it poses a great threat to the health and well-being of the population (Hasan & Chongbo, 2020). The effects of climate change are seen everywhere - low summer river flows, higher seasonal temperatures, glacial retreats, floods, sea-level rise, and also lower household incomes, and increased poverty indirectly (Hasan & Chongbo, 2020; Raza & Hasan, 2022). The main challenge facing any country at the moment is the intricate balance of economic growth with environmental sustainability (United Nations Environment Programme, 2020). Therefore, it has become necessary to study and understand the level and impact of various sources and sectors on CO2 emission in order to properly develop policies to lower emissions and implement them.

Objective

The main objective of this study is to identify the major contributors to CO2 emissions in Bangladesh and gain a better understanding of which sectors to tackle first to regulate the current status quo. Specifically, the purpose is to analyze the level of CO2 emissions in Bangladesh resulting from different sources. We will, in particular, study and compare CO2 emissions due to urbanization, industrialization, manufacturing industries and construction, commercial and public services, and consumption of various non-renewable fuels.

Literature Review

There is a large number of existing literature linking CO2 emissions to various sources and sectors in Bangladesh. Conversely, very few have explored CO2 emissions due to the various sources with a comparative view. Rahman and Kashem (2017) examined the empirical cointegration, long and short-run dynamics, and causal relationships among industrial production, energy consumption, and CO2 emissions in Bangladesh from 1972-2011. They found a unidirectional causality from industrial development to CO2 emissions and energy consumption. The study also suggested policy options such as market-based pricing strategies, community-based awareness, efficient implementation of energy policies and environmental laws to reduce CO2 emissions. Shahbaz et.al. (2014) studied the relationship between CO2 emissions and industrialization in Bangladesh by examining the effects of electricity consumption, financial development, and trade openness. They deduced that an environmental Kuznets curve exists between industrialization and CO2 emissions in Bangladesh. They also found that electricity consumption and financial development adds to CO2 emissions. Additionally, they suggested that the government should implement policies to improve environmental quality, such as promoting sustainable energy and clean technology, regulating dirty industries, and encouraging sound financial development. Raza and Hasan (2022) studied the impact of technical progress on CO2 emissions in the manufacturing and industrial sector in Bangladesh using a quantile regression approach. The results revealed that technical progress reduces CO2 emissions at all quantiles, but the magnitude of the effect varies across the quantiles. They also found that the impact of technical progress on CO2 emissions is more significant in the manufacturing sector compared to the industrial sector. Yu Zhang et al. (2019) studied the relationship between economic development

and CO2 emissions in the manufacturing and construction industries using the environmental Kuznets curve (EKC) model. The results revealed that the turning point for the manufacturing industry occurs at a lower level of per capita GDP compared to the construction industry. Karmaker et al. (2020) suggested that the increase in carbon emissions results from Bangladesh's reliance on fossil fuels. They found that renewable energy-based technologies have reduced CO2 emissions in Bangladesh by 10–30%. Hasan and Chongbo (2020) aimed to estimate the growth of energy-related CO2 emissions in Bangladesh and identify the main factors contributing to the growth. They found indication of efforts toward energy efficiency and clean energy in the country. Additionally, they highlighted the importance of implementing policies and strategies that prioritize the development of renewable energy sources, such as solar, wind, and hydropower, in order to mitigate the growth of CO2 emissions in Bangladesh.

Data and Methodology

For the purpose of the study, we collected data from the World Development Indicators (WDI) database. The WDI is a comprehensive database provided by the World Bank that contains a wide range of socio-economic data for countries around the world. Data was collected for CO2 emissions, CO2 emissions per capita and CO2 emissions from different sources due to production or economic activity in Bangladesh. The study uses the data for the period of 2007-2019.

We sorted and arranged the collected data by sources of CO2 emissions, which includes electricity and heat production, gaseous, liquid and solid fuel consumption, manufacture and construction, commercial and public services, and transportation. We processed and analyzed the data using statistical software such as Excel and R. The comparative analysis involves comparing the CO2 emissions from these various sources through descriptive and summary statistics as well as using graphs and tables to provide a visual representation of the results. We also study the trends over time for the variables. Table 1 below shows the variables taken for the analysis after much deliberation on the sectors and sources that emit CO2 in a country.

Table 1: Variables

Variable Name	Measurement unit
CO2 emissions from electricity and heat production	% of total fuel combustion
CO2 emissions from manufacturing industries and construction	% of total fuel combustion
CO2 emissions from other sectors, excluding residential buildings and commercial and public services	% of total fuel combustion
CO2 emissions from residential buildings and commercial and public services	% of total fuel combustion
CO2 emissions from transport	% of total fuel combustion
CO2 emissions from gaseous fuel consumption	% of total and Kiloton
CO2 emissions from liquid fuel consumption	% of total and Kiloton
CO2 emissions from solid fuel consumption	% of total and Kiloton

Findings

Table 2 displays the summary statistics of the CO2 emissions data of Bangladesh. The results include the mean, standard error, median, standard deviation, sample variance, minimum, maximum and 95.0% confidence level of the mean for each variable.

Table 2: Summary Statistics of CO2 emissions from different sources

Statistics	Mean	Standard Error	Median	Standard Deviation	Sample Variance	Minimum	Maximum	Confidence Level (95.0%)
CO2 emissions from electricity and heat production (% of total fuel combustion)	49.4656	0.6795	48.6246	1.9220	3.6939	47.4474	52.8023	1.6068
CO2 emissions from manufacturing industries and construction (%	17.4512	0.3146	17.5826	0.8897	0.7915	16.0858	18.5328	0.7438

of total fuel combustion)								
CO2 emissions from other sectors, excluding residential buildings and commercial and public services (% of total fuel combustion)	5.8937	0.1931	5.8616	0.5460	0.2981	5.1710	6.6488	0.4565
CO2 emissions from residential buildings and commercial and public services (% of total fuel combustion)	12.5097	0.3946	12.6071	1.1160	1.2455	11.0235	14.3700	0.9330
CO2 emissions from transport (% of total fuel combustion)	14.6832	0.2476	14.5900	0.7004	0.4905	13.7248	16.0848	0.5855
CO2 emissions from gaseous fuel consumption (% of total)	75.1529	1.1630	75.2197	3.2896	10.8214	71.5906	79.2646	2.7502
CO2 emissions from gaseous fuel consumption (kt)	38437.9524	1980.2898	39544.9280	5601.1054	31372381.32	29603.69	45969.51	4682.6413
CO2 emissions from liquid fuel consumption (% of total)	24.0733	0.6227	24.2445	1.7612	3.1017	21.4525	26.7955	1.4724
CO2 emissions from liquid fuel consumption (kt)	12377.0418	850.4181	12130.4360	2405.3458	5785688.24	9915.568	15797.44	2010.9194
CO2 emissions from solid fuel consumption (% of total)	5.9257	0.1616	5.9251	0.4571	0.2089	5.2155	6.7440	0.3821

CO2 emissions from solid fuel consumption (% of total)	3037.6511	185.5008	3047.2770	524.6756	275284.4715	2211.201	3751.341	438.6398

We have found that the mean CO2 emissions from electricity and heat production is the highest at 49.47%, followed by CO2 emissions from manufacturing industries and construction at 17.45%. CO2 emissions from transport have a relatively low mean contribution to total emissions at 14.68%, but it has a narrow range of variation compared to other sectors.

Table 2 indicates that CO2 emissions from gaseous fuel consumption contribute the most to the total emissions, with a mean of 75.15%. The mean contribution of CO2 emissions from solid fuel consumption is the lowest among all sectors at 5.93% whereas liquid fuel consumption has the second-highest mean contribution at 24.07%. Figure 1 below compares the amount of CO2 emissions from gaseous, liquid and solid fuel consumption in kilotons.

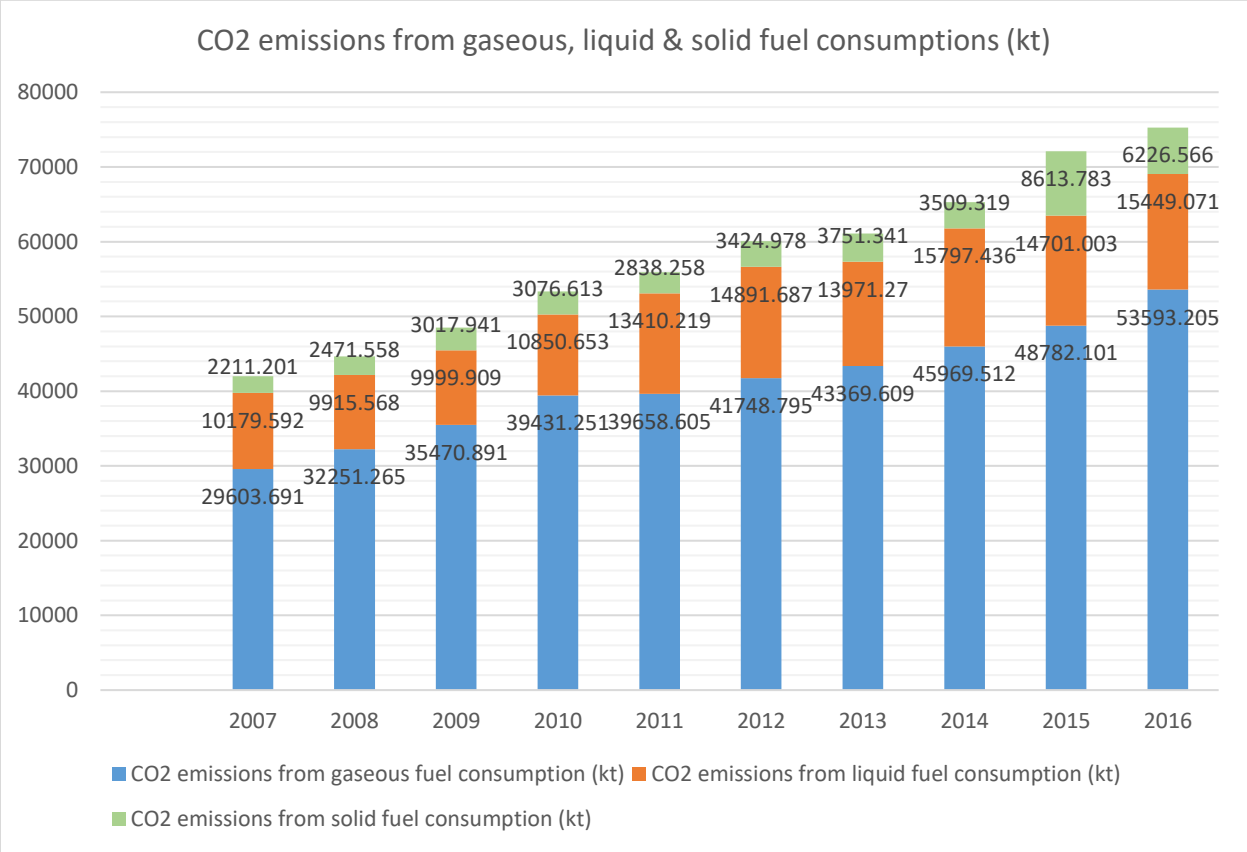

Figure 1: CO2 emissions from gaseous, liquid and solid fuel consumption (% of total)

Figure 1 shows that gaseous fuel consumption has remained the dominant source of CO2 emissions over the years, with only slight and stable increases in emissions every year. It is important to note that, over the years, a comparatively small share of the total CO2 emissions comes from solid fuel consumption, with the majority coming from liquid and gaseous fuel consumption.

The results reported in Table 2 shows that the standard deviations of CO2 emissions from the sources are relatively high for some sources, such as CO2 emissions from electricity and heat production (1.92), CO2 emissions from residential buildings and commercial and public services (1.12), and CO2 emissions from gaseous fuel consumption (3.29). This suggests that there is significant variability in the levels of CO2 emissions from these sources over the period of analysis. The standard deviation of CO2 emissions from gaseous fuel consumption is the highest, indicating the highest variability in emissions. In contrast, the standard deviations for other sources, such as CO2 emissions from transport (0.70) and CO2 emissions from solid fuel consumption (0.46) are relatively low, indicating less variability in the levels of emissions from these sources. The median value of all sectors is relatively stable across the years, with little variation. The confidence intervals for each sector are relatively narrow, suggesting a high level of confidence in the mean estimates.

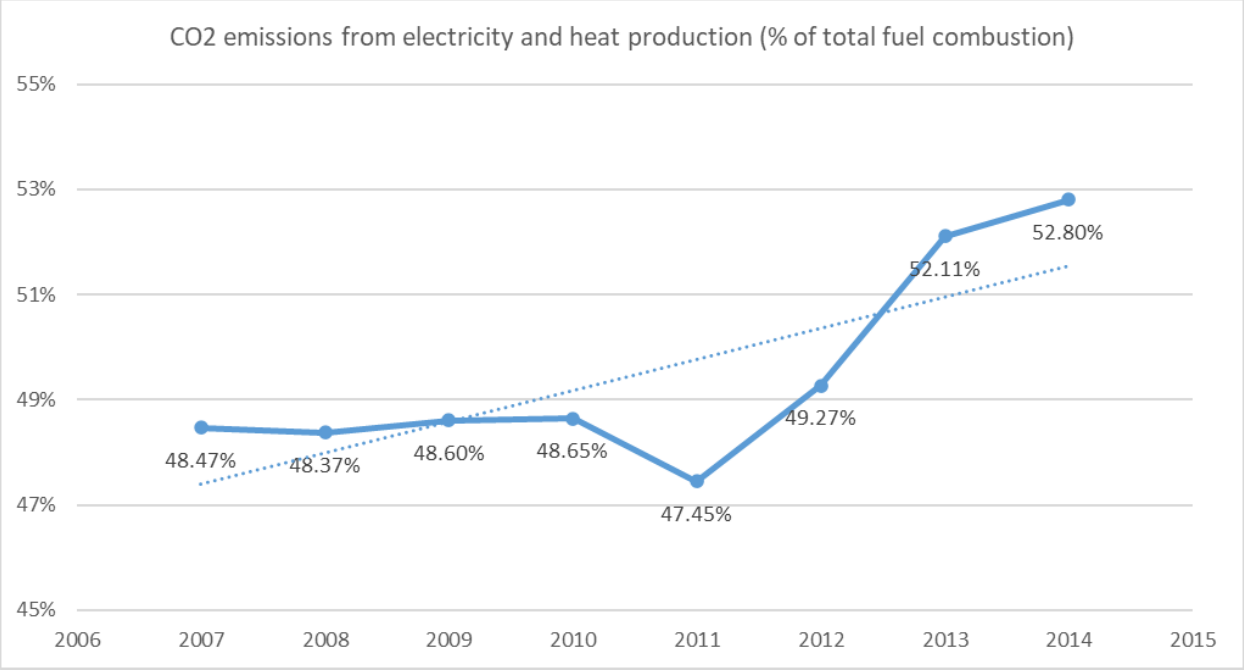

Figure 2: CO2 emissions from electricity and heat production (% of total fuel combustion)

We also can see trends over time for the different sectors and sources. Figure 2 above shows that the percentage of CO2 emissions from electricity and heat production has remained relatively stable but increasing over time, with some slight fluctuations between 2007 and 2014, ranging from 47.4% to 52.8%.

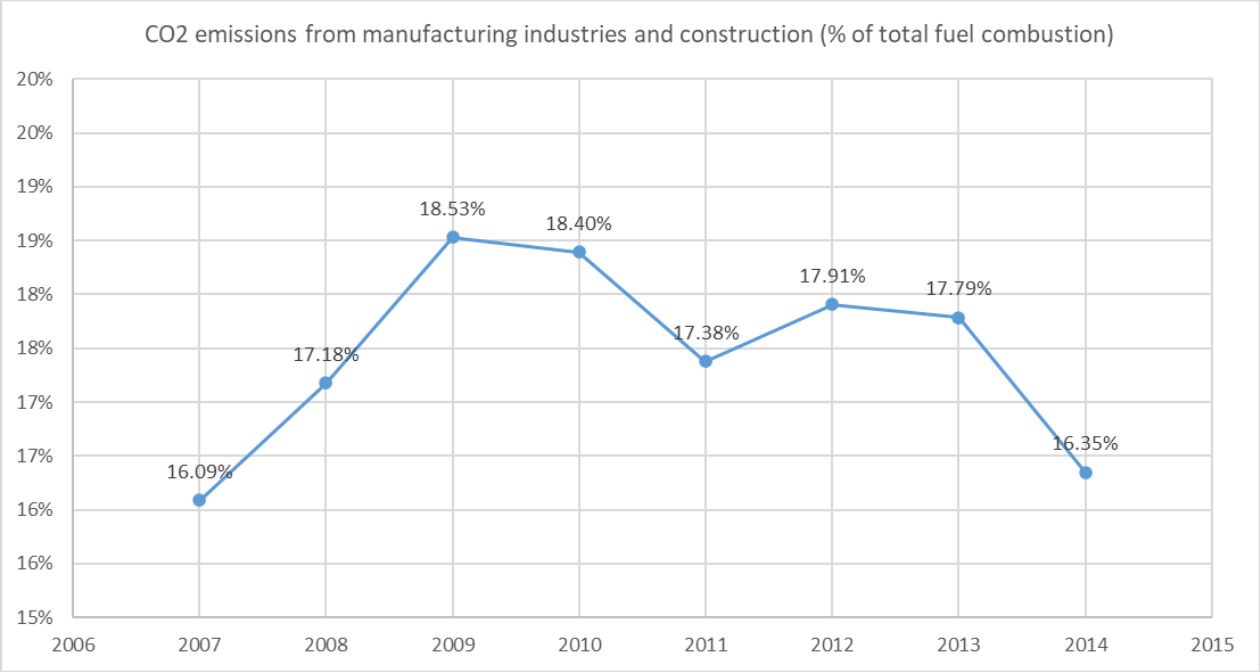

Figure 3: CO2 emissions from manufacturing industries and construction (% of total fuel combustion)

On the other hand, the percentage of CO2 emissions from manufacturing industries and construction displays instability over time. As shown in Figure 3 CO2 emissions from this source increased from 16.1% in 2007 to 16.3% in 2014 with considerable fluctuations in the years 2009 – 2012.

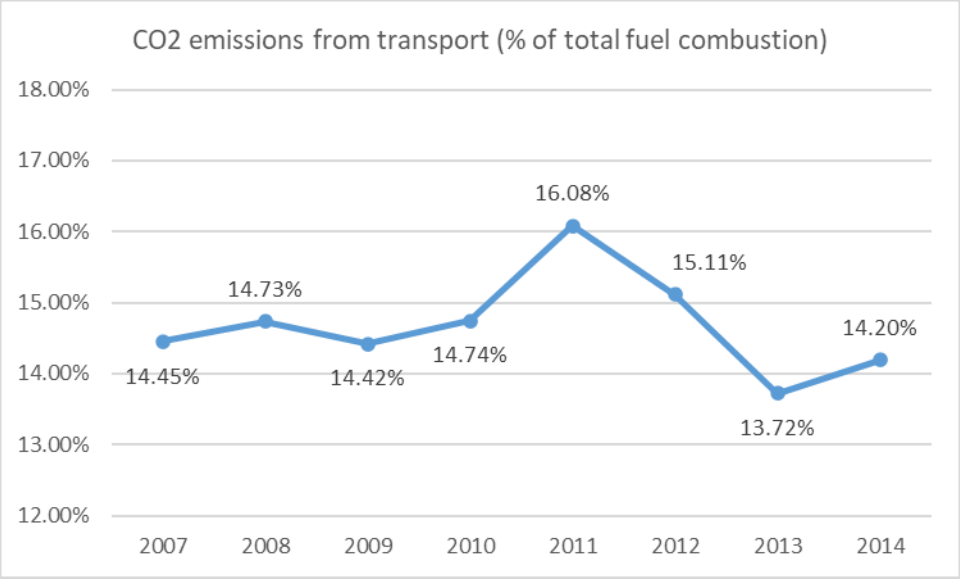

Figure 4: CO2 emissions from transport (% of total fuel combustion)

Figure 4 shows a general trend in the percentage of CO2 emissions from the transportation industry as a proportion of total fuel combustion emissions. In 2007, transportation accounted for a large proportion of CO2 emissions at 14.45%, by 2014, this hadn't changed much and was at 14.20%. But there was a little bit spike in 2011 at 16.08%, which could be due to a range of factors such as policy measures and changes in consumer behavior.

Conclusion

The study analyzes the sources of CO2 emissions with the purpose of better understanding which sectors contribute the most to CO2 emissions in Bangladesh. We have conducted a comparative analysis to identify patterns, relationships, or trends in CO2 emissions over the years 2007-2019. The findings suggest that the electricity and heat production and manufacturing industries are the largest contributors to CO2 emissions. However, emissions from gaseous and liquid fuel consumption should also be closely monitored due to their high mean contributions and variability.

The study suggests that efforts to reduce CO2 emissions should focus not only on electricity and heat production but also on the manufacturing industry and construction sectors. Moreover, policies aimed at promoting renewable energy and reducing dependence on fossil fuels

for production could be effective in reducing emissions. Overall, the data suggest that Bangladesh needs to take measures at once to reduce its CO2 emissions to tackle the adverse effects of climate change with particular attention on electricity and heat production, manufacturing industries, and gaseous and liquid fuel consumption. Further analysis should be conducted to construct targeted mitigation strategies.

Limitations

There is missing data for some indicators for the years 2015-2018. Additionally, the data only covers CO2 emissions from various sectors in the country and does not provide information on other important factors that may influence CO2 emissions, such as population size, economic growth, or government policies.

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