The Transformating Impacts of Sustainable Logistic Practices in Developed and Developing Countries: A Review

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ABSTRACT: Sustainable logistic practices result in economy growth and emission of greenhouse gases. Co2 besides other gases, is a greenhouse gas (GHG) associated with global warming and climate change with imaginable disaster to mankind. In this review, Co2 emission arising from sustained logistic practices in developed and developing countries was assessed. Between 1950 and 1990, global Co2 emission was 6 billion tonnes and it is still rising. Between 2021 and 2023, the estimated Co2 emission for developed and developing countries was 72,027.96 million tonnes from which 77.6% was contributed by developed countries and 22.4% was contributed by developing countries. Within the same period, developed countries had 78.5% gross domestic product (GDP) while developing countries had 21.5%. These suggest that developed countries still apply more advanced sustainable logistic practices resulting in greater Co2 emission than developing countries. Developing countries show lower compliance with international agreement on Co2 reduction than developed countries, probably as a result of lack of adequate technology to lower down Co2 emission. It is recommended that both developed and developing countries should do more to mitigate Co2 emission by embracing renewable sources of power.

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1. Introduction

Globally, and with particular reference to developed and developing countries, sustainable logistic practices have produced considerable and measurable impacts (positive and negative). Global warming and climate change are one of the transformating impacts of sustainable logistic practices such as industrialization, urbanization and deforestation etc. Gases such as carbon dioxide (co_2), hydrochlorocarbon used in refrigerators and air conditioners, Sulphur dioxide (so_2), Methane (NH4) etc, are industrial products associated with global warming and climate change. These gases react with ozone in the ozone layer 18 to 30km up the atmosphere, which protects the earth from direct ultra-violet radiation thus causing ozone depletion and resulting in global warming (Alkins, Cox and Eggleton, 1972). Increase in co_2 level from its normal (0.03%) in the atmosphere to a level above, also typically results in global warming. For example when infra-red radiation strikes the earth, co_2 traps the radiation, causing it not to be re-radiated into the atmosphere, and this phenomenon causes the earth to be warmer than usual (Hekstra, 1985, Manahan, 1994).

With the evolution of logistic operations from the ancient times to the middle age, the 19th century to the 20th century wars, one will identify that at every turn in these timelines, there was a significant theme or focus which helped to propel the development and growth of logistic operations to the next era. From the ancient times around the Egyptian and Roman Empire, the focus of logistics was on storage and the creation of new route to facilitate the movement of troops to distant locations. The middle age was characterized by the creation of more trade ties among the regions of Europe. The 19th century was majorly characterized by the industrial revolution and shipment of the larger quantity of products churned out of the production factories. The need for more efficient means of transportation was also the theme of this era. (Petrache, 2015).

In the late 20th and current 21st century, logistic operations have been characterized by the need for a more sustainable operating environment. The need to ensure a safer global environment for operations has been a growing concern among stakeholders. This was clearly emphasized in Mecalux International, (2023), where the evolution of Logistics and its corresponding characteristic themes were recorded from Antiguity, Middle age, Industrial revolution, 20th century, Digital era, Logistic (modern logistics) characterized by digitalization, artificial intelligence (AI), Interent of things (IOT), route optimization, introduction of autonomous vehicles etc. The need to ensure a safer global environment requires mitigating efforts such as transition to renewable energy, energy efficiency in building, sustainable land and management and carbon

capture and storage (Co2 Human Emission 2017, Global Carbon Budget, 2024).

The aim of this study was to assess Co2 emission levels in the environment arising from sustainable logistic practices in developed and developing countries**.**

2. LOGISTIC OPERATIONS AND SUSTAINABILITY

The key theme in the timelines in logistic evolution reveals the current focus of global logistics to be on environmental sustainability. Thus, the key word to be examining is, Logistics, environment and sustainability.

Firstly, environmental sustainability refers to the responsible management of natural resources to fulfill current needs without compromising the ability of future generations to meet theirs. It aims to balance ecological, economic and social goals, such as reducing carbon emissions, promoting renewable energy and ensuring equitable resource access. The 'Need' in the above definition is further described by Mike Weinstein to mean clean water, healthy food and stable housing and points out that billions of people still lack access to some combination of these needs. For instance, about one in four people worldwide, or 2.2 billion people, lack access to safe water in 2024, (Patterson, 2024). Such a situation had existed in the last decade, Okon *et al* (2018).

Logistics refers to the planning framework that enables businesses to store and transport their goods to their customers. It covers procurement, inventory management, distribution, warehousing, transportation, packaging and risk management.

Lastly, merging logistics and sustainability together being the theme in today's global logistics, it results in sustainable logistics which involves making logistics, goods, and transportation more sustainable, minimizing the environmental impact of the practices involved in these processes as shown in Figure 1 below. At its core, sustainable logistics seeks to balance operational efficiency with environmental responsibility. It's not just about transporting goods from point A to point B, but doing so in a way that reduces carbon footprint, conserves resources, and promotes social responsibility (vasscompany, 2024).

Figure 1: Sustainability Logistics
Source: https://vasscompany.com

3. THE CALL FOR SUSTAINABLE LOGISTICS

In discussing and analyzing the transformating impacts of global sustainable logistics, achievements, setbacks etc, it will be proper to identify the need for sustainability in the first place. The answer lies in over 40 years of global interests, activism by scholars, researchers and stakeholders in environment. The UN conference on the Human and Natural Environment in Stockholm 1972, marked the first remarkable action towards turning the world's attention to the negative impact of supply chain operations on the environment. The participants adopted a series of principles for sound management of the environment which included the declaration of an action plan for the Human Environment. The conference also resulted in the creation of United Nations Environment Program (UNEP). Summarily, the Stockholm declaration placed environmental issues at the forefront of international concerns and marked the start of

dialogue between industrialized and developing countries on the relationship between economic growth and operations, environmental pollution and citizens of the world.

In recording several developments since the Stockholm conference Grant, Wong, & Trautrims, (2017) highlights some of the developments achieved in the course of half a century's stride towards more sustainable global logistics operations. Such events and meetings, among other things, were mentioned, there were;

the Brundtland (1987) commission;
the UN Earth Summit at Rio de Janeiro (1992)- which held that polluters bear the cost of pollution;
the 1997 Kyoto Protocol- which determined green-house gas emission reduction targets for the world;
the 2000 New York Millennium Summit;
the 2002 Johannesburg Summit;
the 2009 Copenhagen Climate change conference;
the 2012 Rio+20 Summit and
the European Green deal

Grant(2017) also deposits that one of the most impactful strides in recent times toward reducing greenhouse gas emission was in the summit of 2015(COP21), held in Paris where 200 countries committed to reduce the impact of CO2 to zero as soon as possible with a target of 2030 to achieve this commitment.

4. GLOBAL CO2 EMISSION

Before the industrial revolution, Co2 emission was relatively low. It started rising up from the middle of the 20th century. It has been reported that in 1950, Co2 emission was 6 billion tonnes which rose up to more than 20 billion tonnes in 1990. For now, emission growth has gone up to 35 billion tonnes each year (Ritchie and Roser, 2020).

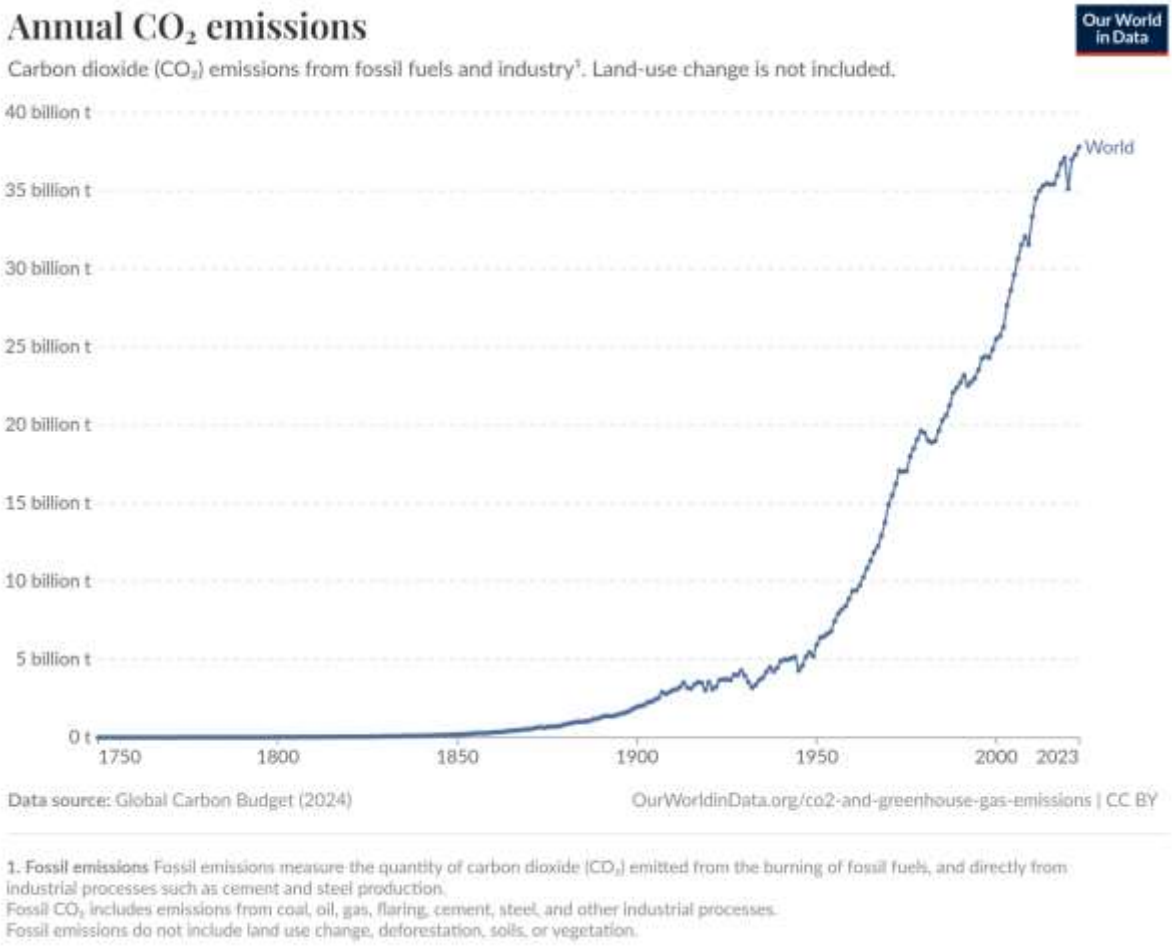

Figure 2: Annual Co2 Emission
Source: ourworldindata.org

The graph above shows the annual Co2 emission from fossil fuel and industry which has shown a decline over time. Beside fossil fuel exploration, other factors such as industrialization, power generation, cement factory operations, transportation, land-use and deforestation largely account for Co2 emission.

On regional basis, United States and Europe dominated Co2 emission apparently through industrialization and transportation in the 20th century (Ritchie and Roser, 2020). For instance, Uk Co2 emission rose up to 600 million tonnes in 1991, although it has declined to 305 million tonnes in 2023, probably resulting from government policies and action for mitigation (Wappelhorst, Mock & Yang 2018).

Between 1900 and 1950, Europe and US had the highest Co2 emission accounting for more than 85% emissions each year (Ritchie and Roser, 2020). This situation has change in recent years with the rest of the world, especially some countries in Asia, example, China emitting more Co2 than US and Europe.

In all human environments, individual persons contribute to Co2 emission to the environment. According to Ritchie and Roser (2020), the contribution of individual persons can be obtained by dividing its total emission by its population which gives us Co2 emission per capita. Looking at emission produced within a country's boundaries without accounting for how goods are traded across the world, this figure might change while accounting for trade as shown in Figure 3, showing very large inequalities in the world. Oil producing regions constitute the largest Co2 emission per capita especially for those with relatively low population size, these countries are mainly found in the middle East and there are Qatar, the United Arab Emirates, Bahrain and Kuwait as against those countries with high population; United States, Australia and Canada have high1 emissions per capita around 3 times higher than the global average.

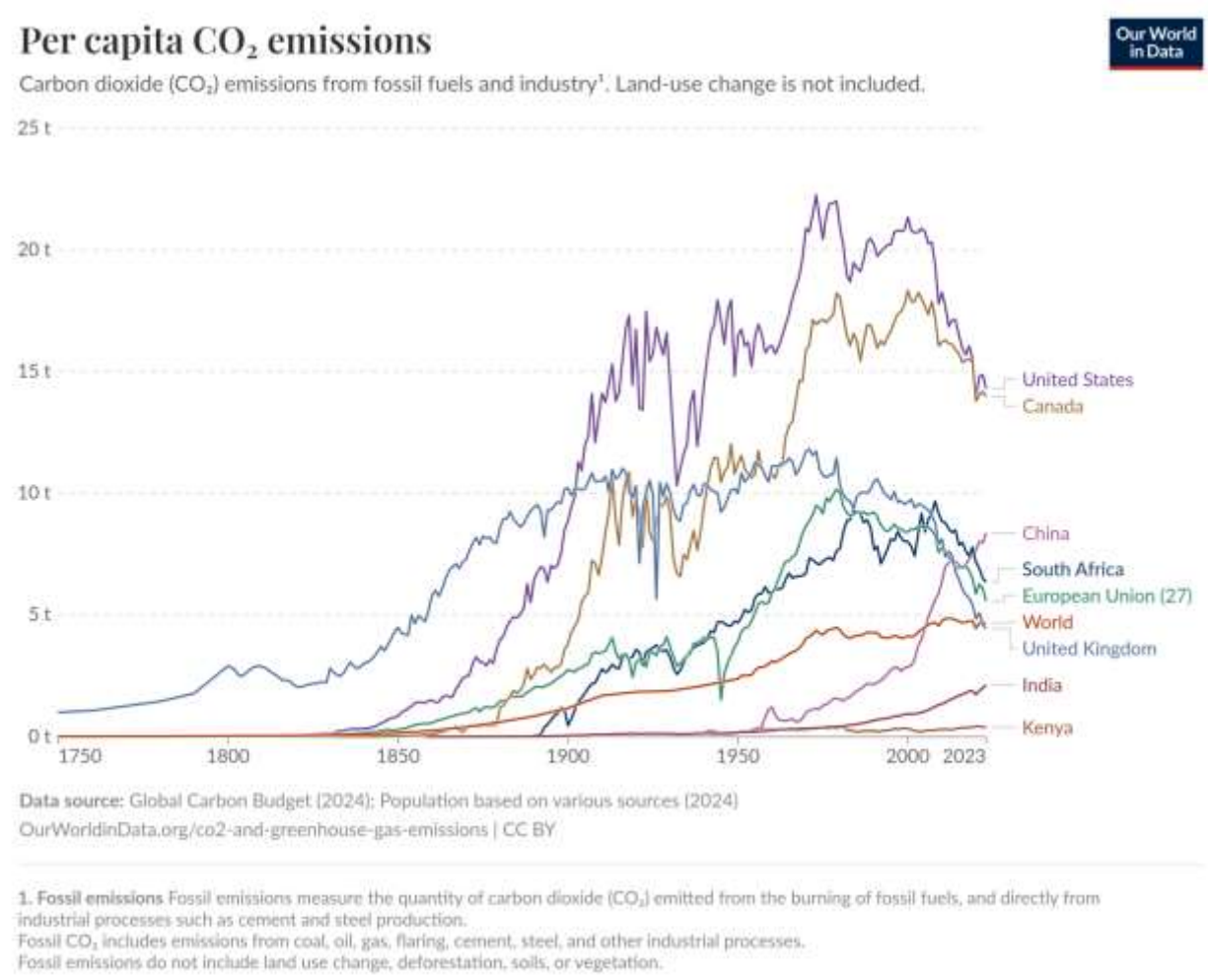

Figure 3: Per capita Co2 Emission
Source: Global Carbon Budget (2024)

It is reported that countries with high income per capita have high carbon footprint. Although, there can be large differences between countries with similar standard of living. For instance, many countries across Europe have much lower emissions than US, Canada or Australia. Power as a factor results in high carbon dioxide emission, most countries in Europe such as Germany, France, THE Netherlands and Belgium emit high level of Co2 not far from global average. However, policy and technological choices make a difference.

As opposed to developed countries, many developing countries, particularly African countries which are rather very poor, have very low footprint around 0.1 tonnes per year on average. That's around 150 times lower than US, Australia and Canada (Ritchie and Roser, 2020). The Co2 emission of Mali and Niger is reported to be equivalent to that of America or Australia. However, oil producing countries in Africa such as Nigeria, Algeria and Angola have relatively higher Co2 emission levels, as evident in 2021, 2022 and 2023 (Our World in data) than their counterparts.

4.1 Yearly Emission of Co2 by regions

India, China and the United States are leading emitters of Co2 as shown in figure 4, showing where Co2 is produced and not where it is finally consumed. Looking at the difference between a country's Production vs. Consumption, Asia leads in Co2 emission accounting for around half of global emission as it is home to almost 60% of the world's population, implying that per capita emission is slightly lower than world's average.

China is however, the world's largest emitter, emitting more than one-quarter of global emission as per 2021, 2022 and 2023 (our world in data 2024), seconded by North America at one fourth of global emissions and followed closely by Europe (Ritchie and Roser, 2020). Africa and South America are small emitters with 3-4% global emission each.

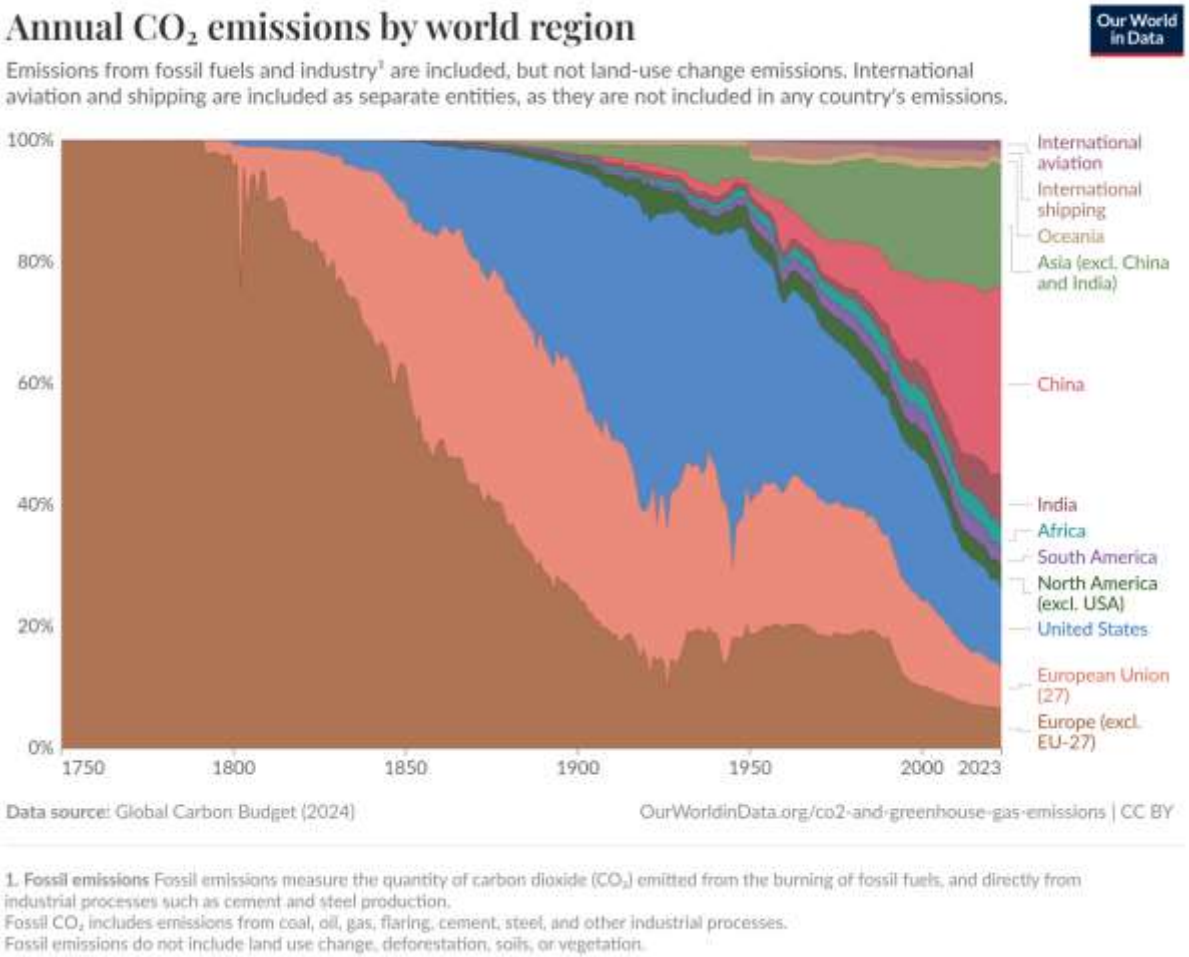

Figure 4 : Co2 Emission by Region
Source: Global Carbon Budget (2024)

5. Comparable Co2 Emission and GDP Per Capita in Developed and Developing Countries

Several tranformating impacts arising from sustainable logistic practices are desirable in both developed and developing countries. From environmental point of view, an example of such impacts may be greenhouse gas (CO_2) emission arising from industrial activities, transportation and various other uses of fossil fuel.

From economic point of view, GDP per capita of a country is used as an example of impact arising from road infrastructure, power, exploitation of mineral resources etc.

These parameters of comparison between developed and developing countries are shown in Tables 1 and 2 respectively. The developed and developing countries were selected randomly and data for co2 emission and GDP per capita were sourced.

In economic sense, several sustainable logistic practices transform the economy of a country by increasing gross domestic product (GDP) and income per capita, improving health services, education, agricultural production and food safety. Such logistic practices may be promotion of commerce and industry, power supply, employment, adequate budgetary allocation to key sectors of the economy of a country.

Table 1: co_2 emission in developed and developing countries

	co_2 emission per year(tonnes)		
developed countries	**2021**	**2022**	**2023**
USA	5.03billion	5.08billion	4.91billion
Uk	344.51million	313.83million	305.15million
Germany	678.78million	671.47million	596.15million
Australia	389.02million	384.36million	382.97million
China	11.45billion	11.35billion	11.90billion
Japan	1.06billion	1,03billion	988.78million
developing countries			
Nigeria	135.07million	131.57million	128.54million
South Africa	425.92million	405.31million	401.89million
Algeria	179.60million	184.56million	178.13million
M1alaysia	273.15million	285.45million	288.82million
Indonesia	619.62million	737.07million	733.22million
Angola	15.91million	20.25million	20.78million

Source: https://ourworldindata.org/co2-emissions, 2024

Table 2: GDP per capita in developed and developing countries

	GDP per capita ($)		
developed countries	**2021**	**2022**	**2023**
USA	71,318	72,842	74,578
Uk	52,872	54,905	54,542
Germany	62,950	63,354	63,574
Australia	57,322	54,805	59,533
China	20,407	21,012	22,138
Japan	44,549	45,175	46,158
developing countries			
Nigeria	5,492	5,553	5,593
South Africa	13,711	13,777	13,690
Algeria	12,757	14,782	15,159
Malay1sia	29,823	32,079	32,812
Indonesia	12,757	13,334	13,890
Angola	7,408	7,397	7,245

Source:https://ourworldindata,org/gdp-per-capita.

In examining these transformating impacts parameters in developed and developing countries, Tables 1 and 2 represent CO_2 emission and GDP respectively in developed and developing countries. The countries were selected randomly.

Among the developed countries, Table 1 shows that China is the highest producers of CO_2 with 34,700 million tonnes while the least is United Kingdom with 963.49 million tonnes between 2021 and 2023. On the other hand, the highest producer of CO_2 among the developing countries is Indonesia with 2,089.91 million tonnes between 2021 and 2023, while the least is Angola with 56.94 million tonnes. This implies that total co2 emission of developed countries on average is 77.6% and developing countries on average is 22.4%, this means that only Indonesia among the developing countries have comparable production of carbon dioxide (CO_2) with United Kingdom (UK), and thus comparable logistic practices.

In Table 2, from economic point of view, United States of America (USA) has the highest GDP with 72,913$ on average, while the least is China with 21,186$. On the other hand, in developing countries, Malaysia has the largest GDP of 31,571$ on average, while the least is Nigeria with 5,546$ on average showing very low logistic practices. This means that total GDP per capita of developed countries on average is 78.5% and developing countries is 21.5%, implying that developed countries have higher standard of living and thus emit more carbon dioxide than developing countries. On the whole, developed countries apart from Indonesia among the developing countries, apply more sustainable logistic practices.

6. CO_2 MITIGATION

Following the 1987 Montreal Protocol which was finalized in 1989 on Climate change from Ozone depletion (Wikipedia, 2025) and the Paris Agreement in 2016 for reduction in Co2 and mitigation (Climate change news, 2023), some developed and developing countries have shown evidence of compliance. Most of these countries focus on reduction of Co2 from fossil fuel, transportation, industries and deforestation without regard to Co2 in the atmosphere.

There are 3 approaches to Co2 removal, and the application of one cannot be sustained exclusively. These approaches constitute a complimentary trinity in Co2 emission mechanism. These approaches are:
1. Efforts focusing on limiting the activities of factors of Co2 emission such as fossil fuel exploitation, industries, cement manufacturing, transportation, power generation and deforestation.
2. Focusing on removing Co2 from the atmosphere by planting trees to sequest Co2 in the environment through photosynthesis.
3. Focusing on government to develop the right and targeted policy and political will to enforce the processes of Co2 reduction.
It is noted that there is Co2 in the atmosphere from emitting sources through sustainable logistics practices. Therefore, reduction of Co2 emission and the Co2 in the atmosphere requires articulated government policy and political will.
Co2 mitigation means reducing Co2 from the atmosphere by removing emission of Co2 from human activities and enhancing natural sinks like forest and oceans that absorb Co2 (United Nations Development Program, 2024).This involves decreasing the amount of Co2 released in the atmosphere from various sources, such as burning fossil fuels for energy, industrial processes and transportation etc.
The importance of Co2 reduction is that co2 contributes to global warming and climate change, which lead to rise in sea levels resulting from melting of ice in the Polar Regions and glaciers and disrupting the ecosystems besides extreme weather events (United Nations Development Program, 2024).
Mitigation strategies include shifting from fossil fuels to sources such as solar, wind and hydropower, and this can reduce Co2 emission.
Secondly, to lower emission, less energy can be used in buildings, transportations and industries.
Thirdly, Co2 absorption can be enhance by protecting and restoring forests which have the potentials to absorb Co2 through photosynthesis, promoting sustainable agriculture and improving soil health.
Fourthly, these practices reduce waste, reuse materials and promote
recycling and can minimize resource extraction and associated emissions.
Fifthly, Co2 can also be reduced by sustainable mobility and planting of trees.
To examine the co2 reduction levels of developed and developing countries, it makes sense to examine global compliance of Montreal Protocol and Paris Agreement, pointing out the co2 reduction profiles of developed and developing countries.
From 1990 to 2023, some developed and developing countries have complied with the Montreal Protocol and Paris Agreement with reduction in co2 emission. The developed countries that have complied are Sweden, Norway, Denmark, Switzerland, Austria, Finland, United Kingdom, New Zealand, France and Iceland (Climate Change News, 2023). On the other hand, between 1990 and 2023, some developed and developing countries have shown significant reduction profiles, examples of developed countries that have shown co2 reduction are United Kingdom with -48.15%, Germany -42.5%, Italy -28.4%, Poland -22.8%, Japan -19%, Russia -15.1%, United States -6.1%, Canada 30.5%, Australia 34.5%, Mexico 86.2%, Turkey 82.5%, China 449.2% while developing countries are South Africa 26.5%, South Korea 110.8%, Brazil 111.3%, Saudi Arabia 258.2%, Iran 273.6%, Indonesia 317%, India 392%, Vietnam 1712.8%, (Statistica, 2025).
This compliance depends majorly on the policy and political will of each country which is lacking in many developing countries especially African countries.

7. CONCLUSION

While the developed countries have clearly defined targets towards reducing or eliminating greenhouse gas (GHG) emission for better sustainable operations, the developing countries are lagging behind thereby drawing global efforts backward.
On the whole, sustainable logistic practices results in transformating impacts such as greenhouse gas (GHG) and gross domestic product (GDP) world-wide. However, such impacts are more evident in developed countries. Whereas the consequences of GHG such as heat wave, flood etc, are experienced in both developed and developing countries, higher GDP per capita more positively stabilizes the economy of developed countries and more likely the developed countries emit more greenhouse gases. In this study, it has been shown that co2 emissions in developed countries is 77.6% even with 60% compliance of the Paris Agreement of 2016, and 22.4% in developing countries. GDP is 78.5% in developed countries and 21.5% in developing countries which implies that developed countries contribute more to climate change. It is recommended that developed countries should do more to reduce greenhouse gases while developing countries should evolve more stable policy and political will to bring down greenhouse gases.

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