

The Role of Aviation Industry in the Destruction of Environment

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Abstract

As we know that there are more than 10000 airports assist the 15001 flights in all over the world. These flights cover the distance of approximately 15M kilometers. About 2.2×10^9 passengers use that source of transportation in order to get rid from heavy traffic and to save the time. As well as goods also transported through the air system. Aviation industry provides career opportunities to about 32millions in all over the world, it significantly contributes in the economy of the world. But there are many issues arising regarding to the increased trend of airline application. In that time of advance technology aviation industry have to face many challenges due to the increasing level of CO₂ in the air which leads to global warming, also causes the destruction of natural habitats of living organisms hence increased possibility of endangered species especially that are living in open places. More and more airports are established on the increasing demand of people for air transportation. During the process of construction of an airports many things disturb like a piece of land comprises of many acres. With the increase in the population no. need for houses is also increasing. Now there are two challenges. Make arrangements for the survival of population like more houses, factories and industries. With the increase in population growth global warming and pollution also increases. Establishment of new airport in order to facilitate the people with comfortable transportation demands many acres of land as the result in order to meet the demand of land agricultural land is converting into other forms it also disturbs the life. A single air craft

produces many tons of carbon dioxide, CO₂ is the main source of global warming as it forms a layer around the earth crust as the result waves of longer wavelengths could not cross the barrier of CO₂ and meanwhile they come back to earth surface and results in the heating up of earth.

Keywords: approximately, passengers, endangered, challenges, opportunities, global warming

Introduction

History of aviation industry

1st flight was taken in the starts of 18th industry with the invention of hot air balloon that could assist humans to travelling in the air. On the other hand glider operation was carried out by the G. Cayley in the beginning of 19th century.

Aviation industry got introduced in the starts of 19.th century when wright brothers took 1st flight of about 10 to 12 seconds after the research of many years. In the starting people were flying only by using the gliders and balloons. Aviation is not only using as a source of transportation but also assisting in the protection from enemies through jets. But still less attention was paying on the development of that industry. It needed most when WW1 took place, to transfer the injured and for the locomotion of accessories. 1st aero engine was introduced in 1908 that was heavier than the normal air. Airplane was bought by America in about 30000 dollars. In 1947 radar technology was introduced in airplanes which lead to many improvements like fast speed and controlled weight [1].

Growth of aviation industry

From the 1783, thousands of airplanes are introducing annually with the purpose to facilitate the people. It is estimated that aviation industry of china developed by 12% every year. While studies show that demand for aviation industry is increasing 5% per year. As the no. of flights are

increasing % emissions of greenhouse gases like NO_x and Sox also enhancing. No doubt aviation industry is adding significantly in the GDP of any country. But issue is that air transportation is considered as major contributor towards the air pollution. It is estimated that a typical flight jet adds the production of about 700 tons in the air. IPCC claims that if the application of airplanes going on the same routine then it will become the one of the most contributing factor in Global warming. Emissions of GHGs especially CO₂ is depend on the altitudes of the flights like if an aircraft take flight on the average height from the earth surface then it emits about 700 tons of CO₂. But if it takes the flight in higher ranges cause the production of more GHGs as compared to the normal level.

Aviation and its impact on environmental condition

Aviation is producing a great change in the lives of its users by reducing the actual time required for the covering of distance with overloaded traffic problems. Hence it is a miracle that can drop from one country to another within no time. Although importance of air transportation cannot be ignored but on the same time it is contributing negatively to our environment as it cause the noise pollution especially it disturbs the sensation of people living near the airports. Persist level of noise disturbs their sleeping cycle. When they have not peaceful sleep then it leads to psychological issues it means aviation has long lasting effects on the hearing power and mental peace of humans.

Although aviation industry facilitate the people with fastest means of travelling but it is disturbing the life as well in different ways like operation of aircrafts produces a lot of noise

As well as it being the one of the largest emitter of GHGs like NO_x, Sox & CO₂. Carbon dioxide provides shielding effect for the emission of harmful gases from the earth surface when these waves of longer wavelength reflects back in the atmosphere shield gas does not allow to do so. As

the result these wavelengths remain entrapped in the earth and cause to the increase of the temperature of our planet hence aviation results in Global Warming.

Reasons for the emission of large quantity of carbon dioxide includes

Aviation and increased land requirement

As the demand for air transportation is increases, need for airports and aircrafts also increases. In order to construct an airport it needs a piece of land comprises over many acres. Hence along with air pollution by emitting hundred tons of CO₂, It also causes the destruction of many plants in the form of plain area of land for airport establishment. As we know that the plants are natural indicators, absorb the harmful chemicals of environment as free of cost. And when they are being cut down for the purpose to gain the more & more land to meet the increasing demand of houses and for business purposes like markets, malls and airports etc. when agriculture land changes into the commercial land it changes the whole cycle of natural recovery like trees when absorb the harmful substances from the environment then clouds formation takes place but when plants and trees cut down more and more storms takes place which is harmful for humans as well as animals and plants.

Effects of Aviation on the air quality

Studies shows that demand for air transportation has been increasing by 5- 8% per year. That happens when more aircrafts introduce in aviation industry it proved that a single air craft produces about 700 tons of CO₂ and although aviation industry contributes about 2-3% in the total annual production of CO₂ by humans which is 8%. Anyways it cannot be ignored, air transportation do not only for carbon dioxide contributes but also cause the increasing level of NO_x and volatile compounds. Studies show that oxides of nitrogen are increasing every year with 0.5% like in the starts of 21st century emission of oxides is reported as higher among the other GHGs, while

emissions estimation in 2016 shows 45% increase than earlier anyways these emissions decreased during the last 2 years of COVID-19. The reason for reduced emission of these harmful gases is that during the Pandemic period of corona virus there was temporary ban on all types of transportation especially on the air travelling from one country to another [2].

Volatile organic compounds

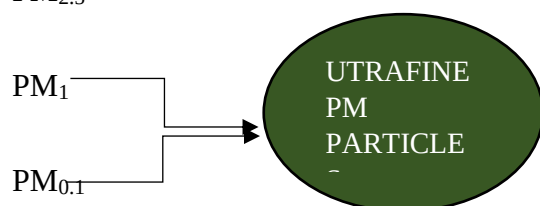
These are regarded as among the most dangerous chemicals that are polluting our environment and their production is increasing day by day due to the increase of aircrafts population.

Particulate matter

The term PM is employed for the smallest particle of liquid or solid. These are produced during the burning of carbonaceous fuel in the engines of aircrafts. It is proved that mostly 4 types of PM matters produced in the combustion of kerosene oil

PM₁₀

PM_{2.5}



These particles have the capacity to penetrate into the bronchial system and cause the asthma and emphysema. PM enters into the blood fluid and damages the hereditary matter and leads to the uncontrolled division of cells and causes cancer [3].

Ozone

Ground level ozone gas produced when free radicals interact with the ozone layer as well as also produced from the refrigerators and air conditioning system. Although ozone layer present in

stratosphere has protective function but ground level ozone gas is very dangerous for living organisms as it interact with the respiratory system and damages to it as the result severe respiratory disorders happens.

Importance of study

As aviation industry is facilitating people with fastest and convenient mode of transportation. It is also providing millions of career opportunities for the people. As well as it is also help in the economy of a country. Air transportation got introduced in the start of 19th century. But studies proved that harmful emissions from air transportation is interfering with nature. In order to control the harmful emissions of GHGs from the exhaust of engines, many policies have been made as well as emission standards also set by EU to overcome that issue. In the starting it was used on smaller scale but with the passage of time air transportation is employing by passengers, for military operations as well as for the transfer of goods. All human activities are greatly affected by the pollutants emitted during the working of aircrafts. Although amendments are made for the conservation of environment but they proved beneficial only for a short period, although carbon emission standards set for each aircraft for the control of CO₂ production but it did not give satisfactory results because thousands of aircrafts are adding in our air transportation to meet the needs of public every year. Harmful emissions are produced when the fuel burnt in the engines of aircrafts. It is proved that use of light weight material for the construction of engines is assisting by producing low quantity of harmful gases but we need more treatment for the recovery of nature in order to protect our environment the need is to focus on sustainable aviation development. In our study we will focus on the production of SAF to achieve the goal of sustainable development [4].

Study gap

Sustainability can be achieved by the introduction of biofuel for the operation of aircrafts. Although biofuel is the best solution to meet the goals although it requires longer period for the production of jet biofuel by organic waste material because it demands additional features in the engines of existing fights. Main challenge is to focus on the ways to achieve the SAF. Previous studies reported the methods for the production of biofuel from organic waste but due to poor administration it could not followed there is severe need of implementation so that harmful emissions produced by the combustion of traditional fuel can overcome [5].

Literature review

It is not possible to evaluate the significance and growing need of Aviation industry. It not only provides comfortable and easy access to destination as well as conserves the time. As we know that with the population growth demand for resources like houses, transportation & industries is also increasing to meet their needs, so traffic is increasing at the greater rate as the result a lot of time is wasted. Sometimes in emergency cases when it becomes urgent to reach on the time, air transportation serves as the quick source of travelling [6].

Air transportation is using on the large scale by people as the fastest mean of travelling. Aviation has many advantages but the emission of harmful substances during the flight operation of air crafts is one of the major problems that needs attention. It is concluded that annual emissions of GHGs specifically quantity of CO₂ reported as 750 Million tons in 2004-2005. While a report in 2017 presented that annual emissions of harmful exhaust gases from aircrafts was about 900 million tons [7].

	CO ₂ emissions in 2030 (Tg)	CO ₂ emissions in 2030 (Tg)	Ratio of CO ₂ emissions to 2002
Case 1	488.19	1608.64	3.289
Case 2	488.19	1394.05	2.850
Case 3	488.19	1246.01	2.548
Case 4	488.19	1099.15	2.247

Table presents the production of carbon dioxide in the early 21st century, emission calculations reported from the different airlines in the year 2002 on the basis of previous data emission per km of fuel also being calculated as we know that human activities contribute 8% in the total production of CO₂ while aviation add 2-3% annually in the total production of GHGs included both carbon based and non- carbon emissions like NO_x, Sox & PM.

Studies show that for the control of harmful emissions from the aircrafts many advancements have been made. All the amendments made with the purpose to lessen the effects of harmful emissions on the environment. That goal is achieving through 2 ways

- Development in technology
- As well as policy mechanism is introducing for the recovery of environment [8].

Development in technology is related with the changing in the engine, also has effect on the fuel consumption as we know that burning of fuel is responsible for the production of harmful GHGs. So if we introduce modification in engines of aircrafts it can improve its efficiency by reducing its need for fuel. When less fuel will burn it will allow the production of lesser quantity of CO₂, NO_x and Sox. It proved engines that are functioning now a days working with greater efficiency as compared to machinery of engines that were functional 10 years ago. Aviation industry is

employing those aircrafts that are made up of lighter weight materials hence weight of raw materials is directly related to the quantity of greenhouse gases. [9] Aircrafts that are using in 2020 for flight operation emitted less quantity of carbon dioxide as compared to the conventional engines of past. Modified engine do not reduce the production of CO₂ as well as also produce other pollutants in low quantity.

During some recent years aviation industry started paying attention on the serious issues of

- climate change
- Air pollution

Cowper Grobois et al 2011 reported the behavioral changes of some airports, they examined that air transportation followed by these airlines carried out through the aircrafts that are more efficient as compared to the engines employed in 1900-1999 period which showed the higher emissions of toxic pollutants. Main reason for increased air traffic is that distance that is covered on aircrafts could not overcome by using other means of transportation. When highly developed engines are employed they do not only save the fuel consumption as well as lead to less emission of harmful substances that are increasing health risks of lungs and skin. When lower quantity of GHGs produced it means no more climate change.

That all become possible through the

- a. Modified body of engine of aircrafts
- b. Addition of winglets in the existing body of airplanes so that friction can be reduced and low resistance causes the lower consumption of fuel.
- c. Construction of weight less engines
- d. Regular washing of engine and changing of engine's oil

These all amendment not only reduce the emission of harmful pollutants as well as also helpful in the promotion of business. Passengers also prefer to travel on the flights that produce less noise.

Pollution reduction & conservation of environment

Noise pollution

Noise reduction also reported, it also become possible due to the use of modified machinery of engines in the aircrafts as well as advanced methods for their operation. Modified technology also helped in the conservation of money, resources and environment specifically.

Recycling of waste material

In order to control the waste production in the airports “Recycling” introduced. It is proving beneficial in many ways like when less quantity of waste produce then the resources that were using for the management of waste can save as profit.

Water pollution

Water pollution is also reduced with the use of modified technology in the aviation industry like in the starting more and more water used for the cleaning purposes but when waste production reduced then it allows the conservation of water resources as well as rainwater & greywater is using for multiple functions in airports.

Impact of technology on financial condition

Lynes & Dredge reported that modified engine do not only serve as ecofriendly as well as aid in the improvement of economic conditions. Fuel that was using in the aircrafts costs too much and less profit as the result management could not find any saving to improve the quality of

engine fuel. But when they started to use weightless material for the construction of most of the parts of aircrafts it became possible to focus on the introduction of alternate fuel.

Table CO₂ Emission monitored by multiple source

	NASA calculation 1976	NASA's account in 1984	NASA calculation in 1992	ANCAT calculations of 1992	DLR 1992 account	NASA' s investigation made in 2015	ANCAT's results of 2015	DLR's analysis 2015
The Civil Subtotal contribution	55.34	74.44	97.91	98.22	96.50	247.72	234.19	232.51
Emissions during Military air defense operation	30.67	25.57	21.96	14.66	14.71	17.69	12.50	12.47
Global Total account	86.01	100.11	119.89	112.90	111.23	265.41	246.71	245.10

Table shows the distribution of GHGs emissions reported from different sources. 1st column shows the emissions when air transportation used by people in multiple sections of time, while the 2nd column shows the emissions emitted during the defending operations by army. Recent studies shows low quantity of emissions because these engines involved advanced set up as compared to the conventional flights that consumed more fuel to overcome the resistance due to the friction.

Table 4 presents the harmful exhausted emissions from aviation

	“FESG FC1 2050	“FESG FE2 2050”	“DTI 2050”	“EDF IS92c 1990”	“EDF IS92c 2050”	“EDF IS92c 2050”	The EDF IS92e 1990
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Consumption of fuel	253.7	757.4	633.1	178.0	834	178	178
Emissions of CO ₂	218.0	651.6	N/A	153.1	720	152	154
The possible & reported NO ₂ emissions	3.81	8.62	4.45	1.96	5.77	1.96	1.94

Calculations mentioned above shows the expected emissions of CO₂ & NO₂ on the basis of fuel consumption. If recent trend of emissions take place then the pollutants emissions can be estimated.

Table presents the average costs of external transports in 2000

	The Road Passengers	Passengers of Rail	Air transportation users	Freight on Road	The Rail Freight	Freight in Aviation
Accidents ratio	32.3	0.7	0.3	7.5	0.0	0.0
Noise in various modes of transport	5.0	3.8	1.7	7.3	3.1	6.8
Air Pollution contribution	13.1	6.8	2.3	42.7	5.2	15.4
Change in climate	16.4	6.1	46.1	16.8	3.1	235.6
(Climate change low)	(2.3)	(0.8)	(6.5)	(2.3)	(0.4)	(33.6)

Table presents the costs on multiple categories of transportation of passengers as well as on the transfer of goods by road, through Rail transportation & by air transportation.

Hypothesis H₁

If more passengers used to travel on air transportation then there is greater quantity of exhaust emissions.

As we know that air transportation is the fastest means of travelling, demand for travelling by airline is increasing. People used it frequently because there is heavy traffic on the roads so in order to travel on long distance & to avoid the discomfort they prefer air transportation instead of by road travelling.

Hypothesis H₂

If more exhaust emissions emitted, then it will significantly contribute towards the environmental destruction.

It is estimated that a single aircraft produces about 700 tons of CO₂ annually, when people will rely on the air transportation then there is possibility of unlimited quantity of GHGs. As we know that GHGs are interfering with ozone layer and leading to the global warming which is quite alarming.

Aims & objectives of the study

Aims

Study is performed with the aim to find out the factors of aviation that are destroying our environment like, Aircrafts emit several tons of GHGs, Due to which many health issues arise, People diagnosed with cancer, lungs disorders and skin diseases, As well as find the ways to mitigate these emissions in order to protect the environment from further destruction [6].

Objectives

That study is designed with the purpose to find out the environmental risks associated with the air transportation, as it proved that it is the fastest mean of transportation. People preferred to use the aircraft for transportation in order to conserve the time and to avoid the heavy traffic of vehicles on the roads. But studies show that air transportation is contributing towards the addition of CO₂ in our environment in greater amount as compared to the other sources of transportation. Because aircraft emits the harmful exhaust gases in the environment without any change in the composition of harmful gases as compared to the other vehicles that have modified set up for the conversion of emitted gases into less harmful gases. As we know that CO₂ is the harmful GHGs produced in billion tons during the flight operation annually. Need is to find the modifications in the structure of the flights especially in the engine so that they can emit less harmful exhaust gases in reduced amount. Along with it fuel also needs amendment in order to prevent the production of VOC, PM and unburnt hydrocarbons. Amount of CO₂ will reduce automatically at the end [6].

Study question

To find the possible alternate methods to reduce the GHGs emissions from air crafts so that harmful effects caused by the increased air transportation can be mitigated and the goal of sustainable aviation industry can be fulfilled.

Methodology

Studies shows that application of air transportation is greater than the arrangements made in the field of aviation. As aviation industry is playing significant role in the economy of country so it needs to introduce the sustainable approach in the aviation industry. As we know that fuel is the main source of harmful GHGs emissions that are changing our climate, so need is to introduce green approach towards the production of fuel because burning of kerosene oil produces billion

tons of GHGs so in order to reduce the harmful emissions due to the burning of traditional fuel we should focus on the production of biofuels in the aircrafts.

There are two approaches employed for the production of ecofriendly fuel for sustainable aviation development. Biofuel production approach from natural organic materials, Sustainable Fuel production from thermal methods, although there are multiple methods for the synthesis of jet biofuel but FT is commercially accepted method for biofuel production.

Fischer-Tropsch method

FT production involves the various techniques like

- Gasification
- Pyrolysis
- Liquefaction

Gasification –FT method

Gasification allows the conversion of organic waste reactant into carbonaceous syngas. That transformation carried out on the high temperature of 1000°C. Now the syngas contains 2 important raw materials that will react to produce the Biofuel. Liquid that is generated by employing the FT-Gasification, contains the lower hydrocarbon.

- Like methane
- Ethane
- Propane
- Butane

Now they can use for the energy production in turbines, or can be rectified into the Liquid pure gas or kerosene oil. Further the synthesized compounds can fuse with gasoline in order to complete the production of biofuel jet.

Need for aviation biofuel

Although many policies were designed for the reduction of GHGs emissions from the aircrafts for the protection of environment from harmful effects of pollutants released through the exhaust emissions of engines. Although airlines are following the limits of carbon emission standardized by EU But could not get satisfactory results. As we know that GHGs produces during the burning of traditional fuel oil although advanced machinery of aircrafts allows to consume low quantity of fuel but still relying on it, consumption of oil decreases but the no. of airlines is increasing that are using the fuel to perform their functions. Hence overall emission rate is increasing due to the increased demand for air transportation.

That calculations shows the increased production of dangerous nitrogen oxides because no. of airlines is increasing without any notice just with the aim to facilitate the public. Sometimes people do not find an alternate of air transportation when they have to move from one region to other region. So in that case there is an urgent need to introduce an ecofriendly fuel to minimize the loss of environment that is not controlling on any condition.

Biofuel production through FT method has many benefits like

It uses bio waste material for the production of fuel. It means does not demand wasting of resources for the management of waste material.

There is no need of complex instrumentation for Biofuel synthesis.

Hence it is costs effective.

Produced biofuel do not contain any harmful constituent like Sulphur. [10]

Results & Discussion

Possible methods for reduced harmful emissions

Setting up of emission limits

In 2016 for the control of harmful emissions due to increasing air transportation ICAO has set emission limits according to the rules & regulations that each category of flight will follow a limit during the operation as the result there will release a control amount of GHGs especially CO₂. If a flight stocks out of its emission limits it needs to buy from other flights in order to provide the further comfortable transportation to people. [11] If that rule of limited emission is being followed then it will not only assist in the reduced emission of CO₂ as well as it encourages to focus on the mission of sustainable development in the field of aviation.

As we know that aviation plays significant role in the economy of a country, as it provides opportunities to thousands of people, as well as promote tourism people from different regions of world enjoy the beauty of nature travelled through Airplane. There are many countries whose economy depends only on the tourism like Indonesia if no attention pays on the activity of flights emissions and then the promotion of aviation industry will stops and it will leads towards the destruction. In order to promote the aviation industry we just need to focus on the solution of problems like to reduce the emissions of harmful exhaust gases which are disturbing our environment by increasing the amount of harmful pollutants like VOCs, PM, oxides of Nitrogen as well as Sulphates that are disturbing human health and activities as well as it also increases the ground level of ozone gas which leads to severe respiratory disorders.

Application of advanced technology

As we know that global warming is due to the uncontrolled CO₂ emission from the air transportation, global warming is resulting in the longer summer period and shorter winter season. It also causes the more exposure to sun rays hence leads to the melting of glaciers and in this way flooding become common in the summers. So in order to control over that situation we should use advanced technology for the conservation of our planet earth [12].

As we know that planes and aircrafts operate only on the kerosene oil during their operation many VOCs also produced these pollutants emitted in the upper troposphere and in the lower layer of stratosphere, interact with ozone layer and destroy its composition and make to holes in the protective layer of ozone hence increases the exposure to the sun, harmful rays of sun easily cross the ozone holes and leads to the skin diseases and cancer. So we should use advanced sources of energy like solar plates for the operating of engine as well as we should introduce biofuels. When we will prefer the biofuels as the source of energy then quantity of waste material also reduce as well as production of fuel by using the waste mater will demands less investment hence it is the true green approach towards the fuel production hence it is the most important step towards the sustainable aviation approach.

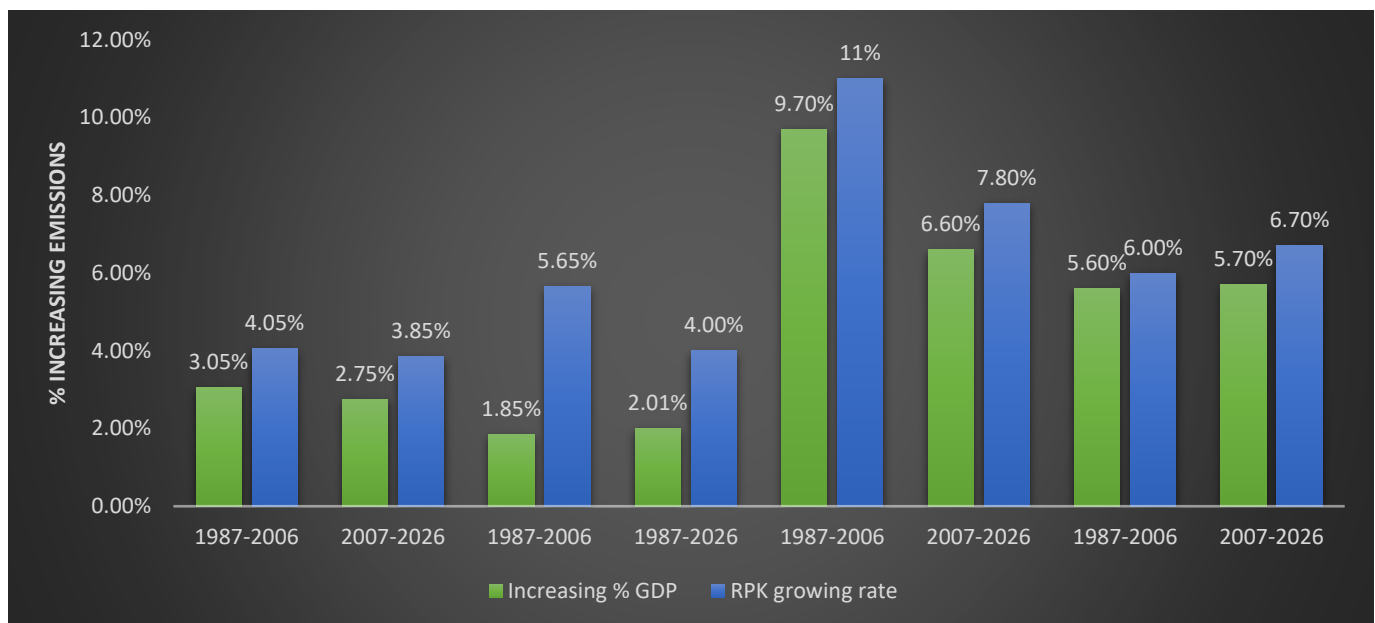
	Aviation growth account of North America		Growth rate in Europe		Aviation growth rate in China		Aviation growth account of Southwest Asia	
Aviation growth distribution	1987-2006	2007-2026	1987-2006	2007-2026	1987-2006	2007-2026	1987-2006	2007-2026
Increasing % GDP	3.05%	2.75%	1.85%	2.01%	9.7%	6.6%	5.6%	5.7%

RPK growing rate	4.05%	3.85%	5.65%	4.0%	11%	7.8%	6.0%	6.7%
GDP-to- RPK ratio	1.2	1.3	2.8	1.9	1.0	1.1	1.0	1.1

Graph shows the development of aviation industry in all populated regions of world

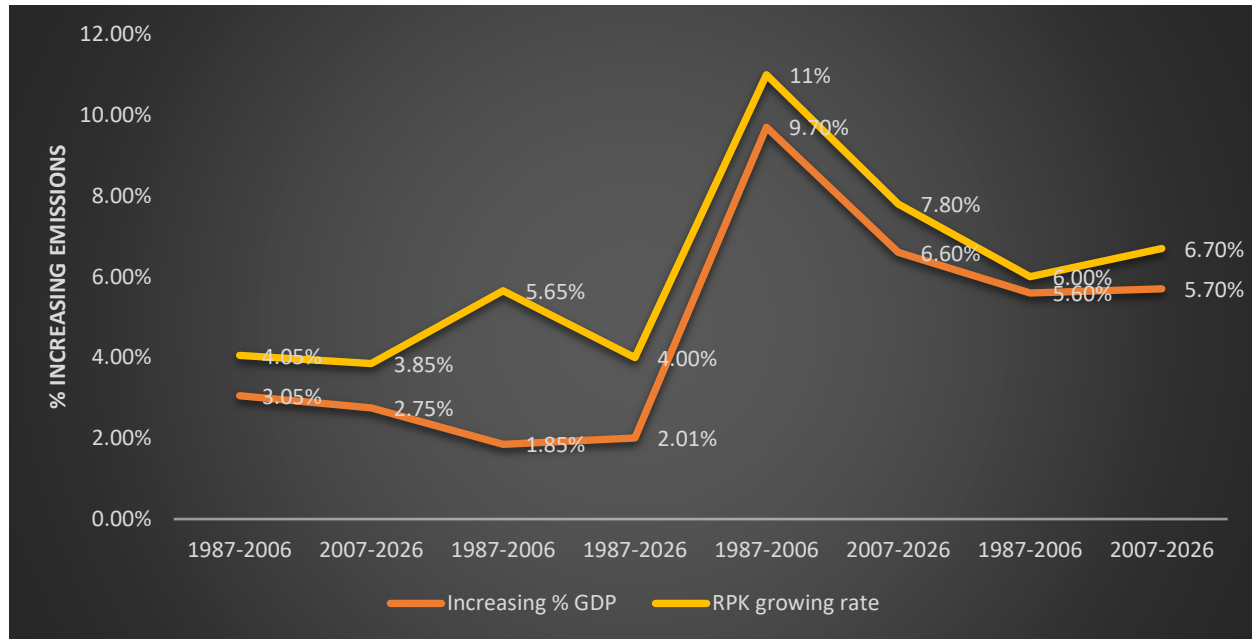
in b/t the specific duration of time and presents the increasing % GDP and no. of passengers that using the air transportation for travelling.

Column graph shows the growth of aviation industry with respect to passengers rate & GDP



Line graph

Shows the relation b/t %GDP & RPK growing rate



Graph shows the no. of people that do not rely on air transportation for travelling

Details	Sample 1(population) million	Sample 2 (passengers) in million	Averaged person taken individually from population	% of people that experienced air transportation
No. of people belong to lower income	706	24	0.031	0.7
People from lower middle class	3022	453	0.051	3.0
From upper middle	2655	1314	0.491	10
People with high income	1211	2441	2.021	40

Table represents the Share of population that are using air transportation

Details	No. of population in million	No. of passengers facilitated with air transportation	Averaged person taken individually from population	% of people that experienced air transportation
No. of people belong to lower income	706	22	0.031	1.631
People from lower middle class	3022	455	0.051	7.511
From upper middle	2655	1314	0.491	24.721
People with high income	1211	2442	2.021	100.01

Calculations in the table mentioned above shows the no. of populations that used the air transportation for travelling in the 2018 among the people belonging to various classes like illustrated in the table: lower middle, upper middle, high income & lower income as well % of passengers from each category that employed air transportation from each respective class.

Table shows the possible emitted CO2 emissions in 2020

Multiple Regions	Million tons emission of CO2 (2020)	Million tons of CO2 emitted in 2050	Per capita emission of CO2 till 2020	Per capita emission of CO2 till 2020
African region	15	54	12	22
The Asia-Pacific	240	955	56	195
The CIS	18	40	79	161
Europe	270	364	249	545

America	46	159	70	208
The middle east	45	181	277	682
North of USA	190	367	520	859

Data presented the details of air operations with exhaust emissions of each region like Asia, North America & Middle East details shows that if that pattern of emissions persist till 2050 then amount of exhaust emissions will increase up to 4 times of the existing trend of emissions.

Conclusion

It is proved that air transportation is greatly affecting our environment, as GHGs produced in the results of combustion of fuel in the engines of aircrafts. These GHGs emissions include the CH₄, CO₂, NO_x and Sulphur oxides. These emissions are polluting our environment as well as causing global warming and destruction of ozone layer. As the result many physical and biological disorders are producing in humans and environment like respiratory disorders, cancer and skin diseases cause in the result of these harmful exhaust emissions from engines of airplanes. In the beginning there were low trends of air transportation people used gliders and air balloons for the travelling in the air. After some years when wrights brothers took 1st flight then people started to travel by employing aircrafts. From then flights are using for the transport of goods from one point to another as well as to accomplished the flight operations by army. Although air transportation is the fastest mean of travelling but there are some challenges that needs the solution, In order to reduce the harmful GHGs emissions following amendments were made, A policies were designed to control the production of harmful gases like, Limiting Emission standards were set for each aircraft, Advanced technology introduced in the engines, Low weight raw material used to reduce the friction, Although these treatments aid in the reduction of emissions but limited to some extent.

It needs sustainable aviation approach as the permanent solution for harmful emission. We should focus on the implementation of green synthesis of fuel as traditional fuel is the main source of harmful exhaust emissions.

Future challenges

Although sustainable aviation is the permanent and effective solution to cut the harmful GHGs emissions. But there are some difficulties facing during the implementation of SAF life synthesis of biofuel requires complex set up and longer time period if proper rules & regulations do not followed then it will cause the contamination of biofuel with Sulphur content which is harmful for the environment and living organisms so it needs controlled set up in order to achieve the goal of sustainability [13].

References

- [1] S. Capoccitti, A. Khare, U. J. J. o. t. m. Mildenerberger, and innovation, "Aviation industry-mitigating climate change impacts through technology and policy," vol. 5, no. 2, pp. 66-75, 2010.
- [2] F. D. Quadros, M. Snellen, and I. C. J. E. R. L. Dedoussi, "Regional sensitivities of air quality and human health impacts to aviation emissions," vol. 15, no. 10, p. 105013, 2020.
- [3] K. Moolchandani, P. Govindaraju, S. Roy, W. A. Crossley, and D. A. J. J. o. A. DeLaurentis, "Assessing effects of aircraft and fuel technology advancement on select aviation environmental impacts," vol. 54, no. 3, pp. 857-869, 2017.
- [4] L. Budd, S. Griggs, and D. Howarth, "Sustainable aviation futures: Crises, contested realities and prospects for change," in *Sustainable aviation futures*: Emerald Group Publishing Limited, 2013.

- [5] L. Budd, S. Griggs, and D. Howarth, *Sustainable aviation futures*. Emerald Group Publishing, 2013.
- [6] L. Chen, "Climate Change Conflict in Sustainable Aviation:-A case study of Cathay Pacific Airline," ed, 2010.
- [7] S. Gössling and A. J. G. E. C. Humpe, "The global scale, distribution and growth of aviation: Implications for climate change," vol. 65, p. 102194, 2020.
- [8] T. Ryley, S. Baumeister, and L. J. T. P. Coulter, "Climate change influences on aviation: A literature review," vol. 92, pp. 55-64, 2020.
- [9] T. W. Lukaczyk *et al.*, "SUAVE: an open-source environment for multi-fidelity conceptual vehicle design," in *16th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference*, 2015, p. 3087.
- [10] K. S. Ng, D. Farooq, A. J. R. Yang, and S. E. Reviews, "Global biorenewable development strategies for sustainable aviation fuel production," vol. 150, p. 111502, 2021.
- [11] J. Higham, S. A. Cohen, C. T. Cavaliere, A. Reis, and W. J. J. o. C. P. Finkler, "Climate change, tourist air travel and radical emissions reduction," vol. 111, pp. 336-347, 2016.
- [12] A. S. Filatyev, V. Buzuluk, O. Yanova, N. Ryabukha, and A. J. A. A. Petrov, "Advanced aviation technology for reusable launch vehicle improvement," vol. 100, pp. 11-21, 2014.
- [13] L. Zhang, T. L. Butler, and B. J. G. E. t. S. S. f. G. I. Yang*, "Recent trends, opportunities and challenges of sustainable aviation fuel," pp. 85-110, 2020.