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INCREASING THE VISIBILITY AND KNOWLEDGE BASE ON AIR QUALITY WITH BIG DATA AND ITS IMPACT ON THE POPULATION HEALTH

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AIR POLLUTION SOURCES - TRANSPORTATION (DIFFERENT TYPES OF TRANSPORTATION)

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1 INTRODUCTION

Transportation is the second-largest source of greenhouse gas emission in the European Union. Global data relating to the emission of greenhouse gases indicate that the main factors of global greenhouse gas emissions in 2015 were electricity generation (29%), transportation (27%), and production (21%) (Liu et al., 2015, Timilsina & Shresthna, 2009). Morán and del Rio Gonzalez (2007) added, that in the transportation sector, road transportation is the largest source of greenhouse gas emission in the EU since petroleum is the dominant fuel source. In the EU, road transportation is responsible for producing more than 72% of greenhouse gases in the transportation sector. The road is followed by air transportation with 13.3%, marine with 12.8%, and rail transportation with about a 0.5% share in emissions. The rest is attributed to other modes of transport. Clearly, there is a huge difference between greenhouse gas production levels in road transportation and other modes of transportation in Europe (Van Fan et al., 2018). Transportation activities conventionally include the costs of internal transportation. With increasing environmental concerns, the negative external costs of road, rail, marine, and air transport, including air pollution, environmental impacts, climate change, noise, and the devices that control them have drawn the attention of governments and procurement companies (Demir et al., 2015, Kreutzberger et al., 2003). The emissions from the various transport sectors entail a mix of gases and aerosols with very different characteristics and effects on the climate.

Jiang et al., (2017) stated that, transportation has adverse effects on the lives people, animals, and plants, and on the change in the ecosystem. Therefore, controlling and examining polluting factors, creating regulations, and considering policies for preventing issues are among the priorities of progressive societies.

2 BACKGROUND

Over the past 30 years, the transportation sector has been recognized as the leading contributor to greenhouse gas emissions, prompting efforts to mitigate its environmental impact (Kok et al., 2011; Ong et al., 2011; Kopelias et al., 2020). Globally, transportation accounts for 26% of total CO2 emissions (Chapman, 2007). This study will first review previous research and compare its findings with this analysis.

Demir et al. (2015) conducted a review to highlight the costs associated with external factors in road, rail, marine, and air transportation, emphasizing the need for accurate pricing policies to address these issues. Estimating these external costs serves multiple purposes, including the development of cost-effective pricing models, better allocation of research and development funds, and a comprehensive assessment of costs and return on investment across different transportation modes and infrastructure. Similarly, Bickel et al. (2006) argue that many external costs—such as traffic congestion, accidents, environmental sustainability, and social and infrastructure expenses—are either not reflected at all or only partially

considered in current pricing structures. Incorporating these external factors into transportation pricing would enhance overall system efficiency.

Greenhouse gas emissions from road transport pose a significant threat to urban air quality and contribute to global warming (Chapman, 2007; Kok et al., 2011; Ong et al., 2011; Kopelias et al., 2020). Various aspects of emission reduction strategies have been explored, including policies aimed at reducing emissions (Dulal et al., 2011; Ong et al., 2011; Demir et al., 2014; Emberger, 2017), the link between environmental noise and road traffic, and its effects on public health (Ong et al., 2011). Other areas of research focus on policy measures to counteract negative trends, such as decreasing reliance on private vehicles, limiting freight transport by road, reducing air travel for cargo and passengers, lowering transportation energy consumption, and minimizing accidents (Dulal et al., 2011; Emberger, 2017). Additional studies have investigated fuel efficiency standards, CO2 regulations for road vehicles, and comparisons between different policies and approaches for reducing CO2 emissions (Kok et al., 2011; Demir et al., 2014). Furthermore, the promotion of alternative fuels—such as electric vehicles, biofuels, natural gas, and liquefied gas—has been encouraged as a means of lowering emissions (Emberger, 2017; Navas-Anguita et al., 2019).

Chapman (2007) identifies automobiles and airplanes as the primary sources of greenhouse gas emissions within the transportation sector. His research examines key factors influencing emission reductions, particularly new technologies like alternative fuels that aim to decrease reliance on petroleum. He stresses the importance of both policy interventions and behavioural shifts in achieving sustainable emission reductions.

Nakamura and Hayashi (2013), in their review, applied the Comparative Study on Urban Transport and the Environment (CUTE) framework to categorize four main carbon reduction strategies: (a) technology, including infrastructure planning, vehicle advancements, and alternative fuels; (b) regulations, such as transportation management, control measures, and service improvements; (c) information, focusing on awareness campaigns, data presentation, and communication technologies; and (d) economic approaches, including pricing strategies and taxation. They also provided an overview of trends and impacts associated with low-carbon transportation initiatives.

Given that marine transportation contributes approximately 3% of annual greenhouse gas emissions, Bouman et al. (2017) investigated potential solutions in this sector. Their research examined technological advancements, operational strategies, reduction potential, and policy measures to achieve effective emissions control. They concluded that by implementing existing technologies, emissions from maritime transport could be reduced by over 75% by 2050.

The transportation sector currently accounts for 23% of total emissions across the 27 EU member states due to its reliance on fossil fuels. If this trend persists, transportation is projected to contribute 50% of the EU's total emissions by 2050 (Emberger, 2017).

According to Huang et al. (2020), the rapid expansion of transportation networks poses a threat to species with extensive geographical distribution. Additionally, factors such as population growth and an increase in GDP per capita have driven rapid economic expansion, which is a key contributor to greenhouse gas emissions in transportation (Berrittella et al., 2007; Timilsina et al., 2011; Lakshmanan and Han, 1997). For example, GDP growth leads to a steady increase in household income, which in turn results in a higher number of vehicles on the road (Hensher, 2008). Economic expansion directly raises transportation demand, thereby increasing greenhouse gas and carbon emissions.

Among different transportation modes, rail transport is considered an environmentally friendly option, generating less pollution compared to other forms of transportation. It is regarded as the most sustainable mode from an environmental perspective (Krezo et al., 2014). Additionally, in terms of ton-kilometres transported per unit of energy consumed, railway transportation is more efficient than road transport. Marine transportation accounts for approximately 90% of global trade, as it is one of the most efficient methods for transporting cargo in terms of both volume and cost-effectiveness. The primary contributors to marine pollution include (1) ship propulsion systems, (2) auxiliary power systems, which supply energy for various ship operations, and (3) auxiliary boilers, which generate hot water and steam for use by the engine room and crew (Kontovas, 2014).

Marine transportation is responsible for nearly 3% of total global CO2 emissions (Emberger, 2017; Bouman et al., 2017). Transporting goods by ship instead of by air can reduce CO2 emissions per ton-kilometre by roughly 90% (Michaelowa & Krause, 2000). Containerships are among the largest contributors to marine CO2 emissions, consuming over 70 million metric tons of fuel and generating more than 230 million metric tons of CO2—accounting for 22% of total CO2 emissions from global shipping. This emission level is 1.3 times higher than that of bulk carriers, 2.2 times greater than oil tankers, and 2.5 times more than conventional cargo ships (Corbett et al., 2009). Additionally, around 70% of shipping-related pollution occurs within 400 kilometres of coastlines (Eyring et al., 2010).

3 CONCLUSION

As we previously stated, road transportation in the European Union is responsible for over 72% of greenhouse gas emissions within the transportation sector. It is followed by air transport at 13.3%, marine transport at 12.8%, and rail transport, which contributes approximately 0.5% of emissions. The remaining portion comes from other transportation modes (Van Fan et al., 2018). This highlights the significant disparity in greenhouse gas emissions between road transportation and other forms of transport in Europe. To reduce carbon emissions in transportation, relevant authorities in the European Union or each county must simultaneously consider technology efficiency and the use of novel technologies (Wang et al., 2020). Moreover, the planning and policymaking variable is very important for achieving

stability in greenhouse gas emissions from transportation (Chapman, 2007, Akbari et al., 2020, Hickman et al., 2012, Hasan et al., 2019, Javid et al., 2014).

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