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ELECTRIC VEHICLES INDUSTRY IN EMERGING COUNTRIES: BARRIERS AND ENVIRONMENTAL OPPORTUNITIES

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Abstract:
Globalization in Automobile industry is one of the significant discussions nowadays in emerging countries. Conventional cars manufacturing in emerging countries has got a great share in global market for many years. Global environmental concerns, climate change due to negative effect of carbon emissions and greenhouse gases lead in increasing the importance of overview the non-renewable fuels consumption patterns to achieve the sustainability. Consequently, most of countries attempted to rise a consciousness about the usage of Electric Vehicles (EVs). However, poor infrastructure technology and high cost of establishing charging stations make the industry capital intensive. The governments set various strategies such as tax reduction and credit offerings. Moreover, investing in establishing production and manufacture units causes opportunities to commence EVs productions in many emerging countries as a developed country. The main aim of this paper is to explain the significance of EVs production in emerging countries and review of validity of Environmental Kuznets Curve Model. In the second part, the emphasizing is on describing the competitive advantage of Türkiye as an emerging country in VEs market globally. The Porters Diamond model and Country of Origin effect are the main discussed the theories.

Keywords:
Emerging Countries, Electric Vehicles, Sustainability

1. Introduction
The industrial revolution and efforts to make world's economies more competitive, environmental degradation has intensified. This is why scientists have concentrated on finding ways to boost sustainable economic growth while paying attention to environmental concerns. Numerous nations have made significant efforts to reduce the harmful effects of climate change and its danger.

Experts believe that most significant causes of climate change and global warming is increasing greenhouse gas emissions includes carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCS), perfluorocarbons (PFCS), and sulfur hexafluoride (SF6). (Pao et al. , 2012). To achieve global goal of lowering climate change to less than 2 °C, many policymakers have been defining a set of low-carbon technologies. (Lamb et al., 2021). (Abdul-Wahab et al., 2015) stated that since the start of industrialization, pollution from fossil fuels, deforestation, and other different human activities has significantly raised GHG in the Earth's atmosphere. CO2 is one of the environmental contaminants that contributes to climate change, accounting for 58.8% of GHGs. Although CO2 is naturally produced, burning fossil fuels like coal, gas, and oil is what leads to its accumulation. According to recent studies, CO2 emissions attributable to fossil fuel consumption account for more than two thirds of GHG emissions. Moreover, the importance of changing the consumption pattern of the energy mix to renewable energies has increased due to finite resources and the significant dependence on fossil fuels in developed and rising countries alike. (Meszaros et al., 2021) argued that the use of fossil fuels for transportation and other forms of mobility is directly to blame for 40% of the world's environmental problems.

From both concerns regarding the environment or rising need for fossil fuels, electric vehicle (EV) industry offers solutions to this process. According to (Zöldy et al., 2013) increasing market share of EVs emphasized the potential

for worldwide expansion, and it is predicted that 130–228 million vehicles would be produced by 2030. (Tran et al., 2020) discussed how well-designed EVs may outperform conventional automobiles in terms of performance and dependability. Electric motors extract power from rechargeable batteries power all electric EVs and are cleaner, quieter, produce no pollutants from their tailpipes as compared to internal combustion engine vehicles. Therefore, consumer demand for EVs is essential for global transition and considerably aids in the preservation of the environment and natural resources. (Tunçel and Buğday, 2021)

(Zhang et al., 2020) pointed out that Norway (55.93%), Iceland (17.79%), the Netherlands (15.01%), and Sweden (11.35%) have the largest market shares for EVs. It is significant to note that, aside from these countries and the other 11, the remaining nations possess 2.5% of the market. According to the principle of the diffusion of innovation, these figures indicate that the EV market is still in the early stages of innovation.

Previous studies have shown that governments play a significant role in market growth and consumer adoption because barriers to the market for EVs, particularly in developing nations, include high end-user prices, longer charging times, fewer charging stations, and networks as opposed to conventional cars (Zöldy et al., 2013). In response to the expanding market share of EVs, the deployment of charging infrastructure is steadily expanding globally (Erdoğan et al., 2022). Nevertheless, the battery is the priciest component of the car, costing 20% to 30% of the entire cost of construction. (Arora et al., 2021). Fully battery powered EVs are less prevalent due to how demanding the battery technology is on performance, which is heavily constrained by battery size. (Zhang et al., 2016). Sustaining the recycling of used batteries is a major issue (Mu et al., 2023). Furthermore, broad EV adoption requires the construction of a significant number of charging stations and associated infrastructures (Erdoğan et al., 2022). In several countries, the high cost of power has resulted in a lack of facilities for producing it. As a result, providing financial sources may provide more challenges for middle- and low-income countries with reduced purchasing power (Meszaros et al., 2021).

The following table lists the problems and recommendations for EV market adoption in emerging economies: (Meszaros and Andrejszki, 2014)

Identified problems	Proposed solutions
Low purchasing power	• Lowering registration costs • Reducing custom duties and annual taxes • Reducing electricity consumer prices for charging EVs
Weak charging network	• Subvention from the state or municipality to put in new charging stations • License for a gas station by requirement to implement an e-charging systems • Integrating EVs system with the Smart Grid
Congestion, pollution	• combining various transportation policy tools where EVs are prioritized • Exemption from traffic control measures and/or use of bus lanes for EVs • EVs for public use, particularly in public transportation

Table 1: Problems and solutions towards EV market penetration in emerging economies (Meszaros and Andrejszki., 2014)

Türkiye is an emerging country with a rapidly expanding economy that results in rising energy use and CO2 emissions. To fight the harmful effects of industrialization on environment, rigorous measures must be taken. The Turkish government's goals include changing the energy mix, utilizing more clean energy sources, reducing reliance

on fossil fuels and coal, investing in renewable energies as a replacement, and promoting EVs industry. In addition to the increased user interest, the government and companies have taken note of this technology's accessibility.
EVs technology is acknowledged to be still practical, useable, and developable in Türkiye, in contrast to internal combustion engine technology. The work done by the publicly and privately supported Turkish Automobile Enterprise Group (TAEG - TOGG) is a prime example of this practice. Manufacturers of commercial vehicles started working on electric public transportation vehicles even before TOGG programs. Several universities have also conducted research on EVs in addition to these.
Based on reports, 889 EVs were sold in Türkiye in 2015; purchases rose by 30% in 2016 and 45% in 2017. Sales numbers rose by a record-breaking 218% in 2018 and by a further 280% in 2019. Due to the economic snag and the global trend of declining demand brought on by the epidemic, a significant increase in sales statistics in 2020 is not anticipated. A total of 17,749 EVs has been sold as of February 2020. The proliferation of charging stations across the nation is another aspect that has contributed to sales growth over time (Ekici et al., 2021). A total of 1126 charging stations were added between 2011 and 2020, one station for every two EVs. While 18 businesses are engaged in sales and marketing, a total of 11 companies invest in the charging infrastructure (Zhang et al., 2016).
According to (Shahzad et al., 2023), Achieving Porters Diamond models key circumstances including highly skilled labor, managerial expertise, and engineering know-how led to the production of spare parts, truck and unmanned aerial vehicles, and automobile manufacturing under international brands like Ford, Toyota, and Fiat. Additionally, it has a favorable effect on consumers' perceptions of Turkish-made automobiles. Although the market for EVs is expanding, Türkiye's competitiveness in it and country-of-origin effect could be seen as opportunities and the region lacks a dominating competitor in the expanding EV industry, giving Turkish makers a better chance.
Finally, to reframe the connection between income and environmental deterioration, the findings of earlier research on the EKC hypothesis framework are utilized. To do this, the current study assumed that the potential of EKC would be impacted by Türkiye's energy mix. Therefore, reconsidering the entire primary energy consumption that has been used is advised rather than the U-shaped hypothesis, which is unsupported for the case of Türkiye, especially when energy consumption is largely taken into consideration, to further offer a novel insight. As a result, it is predicted that by evaluating the routes, the current study will significantly add to the body of literature and provide policymakers with corrective advice for future links between sustainable economic productivity and environmental issues.

2. Literature review

In the literature section, the Environmental Kuznets Curve linkage between CO2 emission, EVs, renewable energy and globalization will be discussed.

2.1. Renewable energy impact and evidence of EKC for CO2 emissions

The literature about EKC has taken a considerable volume and took a crucial interest from much research as it helps in understanding the relationship between economic growth and activity and environmental degradation, it was originally introduced by (Grossman and Krueger, 1991).
Since the initial study by Grossman and Krueger, numerous studies have examined the EKC hypothesis while there are some evidence to support the EKC hypothesis for certain indicators in some countries, it remains a topic of debate and further research is needed to fully understand the relationship between economic growth and environmental degradation. (Stern, 2004)
The basic idea behind the EKC is that environmental degradation initially increases as economic growth creates greater demand for natural resources and energy and produces more pollution and waste. However, as a society becomes more affluent and reaches a certain level of economic development, it becomes better equipped to address environmental issues. (Kaika and Zervas, 2013)
Thus, the EKC suggests that at a certain point, the relationship between economic growth and environmental degradation changes direction. After this turning point, environmental degradation begins to decrease as the economy continues to grow. (Shafik and Bandyopadhyay, 2010)
For the studies about the EKC estimation for CO2 emissions, they have mostly employed fossil fuel energy consumption as an explanatory variable, and recent literature in energy economics, it has advocated for the inclusion of renewable energy consumption.

Many studies supported and proved the evidence of EKC theory such as (Heidari et al., 2015) while involving the relationship between economic growth, carbon dioxide emissions, and energy consumption in five ASEAN countries. As a result, CO2 emissions per capita and GDP per capita showed inverse U-shaped relationship. For (Hove and Tursoy, 2019) it was involved in an investigation of the EKC in emerging economies which resulted in a U-shaped relationship around the world. (Gyamfi et al., 2021) investigated environmental implications of the N-shaped EKC for E7 emerging countries.
(Sinha and Shahbaz, 2018) Study was about estimating EKC for CO2 emissions in India from 1971 to 2015. The results confirmed the evidence of U-shaped EKC, and that renewable energy has an impact on decreasing CO2 emissions. (Bölük and Mert, 2015) Conducted research about the renewable energy, growth and EKC in Türkiye using an Autoregressive Distributed Lag (ARDL) approach.
Renewable energy consumption leads significantly to decreasing the negative environmental influence so for increasing the environmental quality, while non-renewable energy leads to its degradation, (Fakher and Inglesi-Lotz, 2022) have re-investigated the EKC using a new composite environmental quality index (CEQI) introduced by (Fakher et al., 2021) for OECD countries and OPEC from 2000 to 2019, the results approved the evidence of EKC as an inverted N shape for selected OPEC countries and U shape for OECD countries and that Renewable energy consumption (REC) has a positive impact on CEQI while NREC negative impact.

2.2. Globalization and C02

Many studies have been elaborated about the effect of globalization on environmental quality (EQ), especially the relationship between it and CO2 and GHG, while many other factors haven't been ignored such as the spread of technology, and knowledge beyond borders. (Farooq et al., 2022) disscused the relationship between globalization and environmental quality of 180 countries over the period 1980–2016. In instance, several studies proved that globalization impacts positively for increase of environmental quality by decreasing CO2 emissions, while other resulted that it influences it negatively because of transportation, manufacturing, international trade transactions and distributions effects.
(You and Lv, 2018) analyzed the relationship between CO2 emissions and globalization for 83 countries by using the KOF index that measures the economic, social, and political dimensions of globalization. For emerging countries, attending sustainability always represents a challenge despite their economic success, (Jahanger et al., 2022) conducted a study for 73 developing nations from 1990 to 2018 in Asia, Africa, and Latin America, about exploring the effect of the natural resources and institutional quality on carbon emissions during globalization.

2.3. EVs and Co2

The automobile industry and fuel consumption has got an important interest from many researchers for defining the negative environmental impact of increasing CO2 and greenhouse emissions. Therefore, EVs use has contributed significantly to reducing this impact.
EVs in automobile industry has shown a significant impact on CO2 and greenhouse emissions (Fuinhas et al., 2021), especially if the production and manufacturing of EVs and battery are based on renewable energy. While economic growth has been a major factor as they accelerate the environmental negative issues.
(Sun et al., 2023) investigated EV's role in decreasing environmental pollution, Study was conducted for USA, China, France, Germany, and Norway which are considered as five leading economies.
(Brown et al., 2010) conducted a study about EVs in emerging countries and their interaction with standards. Allegorically, (Günther et al., 2015) discussed the role of EVs for supply chain sustainability in automotive industry.
(Nanaki and Koroneos, 2013) conducted a study based on the comparison of the use of conventional vehicles, hybrid and EVs which are used in greek market and impacts while the source of electricity also have a crucial influence. In this context, a study was done for European Union, USA, Japan, China and Australia about CO2 emission from internal combustion engines and battery EVs by (Kawamoto et al., 2019) showed that CO2 emissions were higher from the manufactures of EV's they use non-renewable energy.
(Fuinhas et al., 2021) also has investigated GHG and battery EVs (BEVs) and study resulted that BEVs have an impact in reducing CO2 emissions over CV.

2.4. EVs production and impact of country of origin

The country of origin influences the consumer perception and choices for products or services, and this effect changes significantly from one consumer to another (Wall and Heslop, 1986). To define adequate marketing strategy and production, understanding COO effect and its measurement is imperative (Rezvani et al., 2012).

(Al-Sulaiti and Baker, 1998) Considered that the differentiation between the conception and the type of products has its own impact on the consumer behavior and that it is related to CO. (Lampert and Jaffe, 1997). Consider the country-of-origin effect as a dynamic approach.

COO effect can be positive (asset) or negative (liability) for one country, it may have a positive effect in perfumes products while negative one in high-tech and …. (Cattin et al., 1982).

(Verlegh and Steenkamp, 1999) Discussed the effect of country of origin by using a quantitative meta-analysis based on three aspects: the consumer's attitude, purchase intention and perceived quality. Türkiye, it has been producing vehicles for other brands for many years such as Toyota, Fiat…etc. Nowadays, after launching the production of TOGG EVs and its commercialization, they can have a competitive advantage in the global market, especially that they could benefit from the effect of COO domestically (Yildirim and Ozdemir, 2021).

2.5. Findings and future implications

The objective of this paper is to examine relationship of Co2 emissions, with variables such as globalization, renewable energy, and EVs by precising the evidence of EKC for previous studies. Proverbially, for minimizing CO2 emissions by using EVs, many factors can influence, citing COO and the consumer ethnocentrism, Porter's diamond model. Many studies supported the idea of encouraging the local production for some industries such as EVs using renewable energies for electric batteries will lead to reducing CO2 emissions by avoiding transportation and distribution internationally. This work can be a key for future research including several main insights and explains the main challenges and barriers for implementing EVs production in emerging countries.

As discussed before, the highest need for minimizing CO2 and GHG requires the potential need and awareness for using EVs as prove of significant contribution in reducing pollution coming from different factors such as: transport, industry based on fossil fuels energies, international shipping…, represents a big threat to environment.

Most of the pollutant countries are emerging countries with low-middle income such as China, Indonesia, Bangladesh, Thailand, and Vietnam. According to study by the World Bank, about 95% of premature deaths because of this air pollution is on these countries. These issues can be an incentive for manufacturing EVs in these countries by using the renewable energies sources, because one of the biggest barriers of industry is capital-intensive nature in term of the infrastructure and charging stations. Indonesia as the second emitter of CO2 emissions after India in 2019, has highly encouraged usage of EVs to achieve zero emissions by 2060. China took place after this opportunity in producing EVs in Indonesia, with their Wuling brand. (Li and Setiowati., 2023) Conducted a recent study in 2023 in this purpose by analyzing the brand image, brand awareness, perceived risk, and COO effect for the Indonesian consumers. Study results proved that the purchase intention of Indonesian EVs consumers is affected positively by the CO, brand image and perceived risk.

This study, revealed several future implications for research, they can investigate in several fields:

- Infrastructure Development: by studying charging infrastructure deployment strategies, evaluating the feasibility of various charging technologies (e.g., fast charging, wireless charging), and identifying the optimal locations for charging stations.
- Battery Technology and Performance: by exploring the development of affordable, durable, and high-energy-density batteries. Additionally, the research on battery recycling and second-life applications can contribute to sustainable battery management and it would interesting.
- Cost and Affordability: by analyzing the factors influencing cost of EVs including production, battery prices, and government policies. Studying innovative financing models, subsidies, and incentives can help make EVs more affordable for consumers and foster their adoption.
- Policy and Regulatory Frameworks: by examining the effectiveness of existing policies, identify barriers and gaps, and propose suitable regulatory measures to incentivize EVs adoption. This includes studying taxation policies, import/export regulations, emissions standards, and credits, and charging infrastructure regulations.
- Environmental Impact: by assessing the environmental benefits of EVs adoption in emerging countries. This includes evaluating the reduction in greenhouse gas emissions, air pollution, and noise pollution

associated with EVs. In instance, the life cycle assessments comparing EVs to conventional vehicles in the local context can provide insights into the overall environmental impact.

• Consumer Behavior and Awareness: by exploring consumer attitudes towards EVs, awareness, and concerns related to range anxiety, and vehicle performance and barriers. This can help shape marketing strategies and educational campaigns to promote adoption.

• Local Manufacturing and Supply Chains: It can provide economic and strategic implications by assessing the feasibility, benefits, and challenges of developing local capabilities for EVs production and explore collaborations with international stakeholders.

• Energy Management: by studying the integration of EVs charging infrastructure with renewable energy sources.

• Socioeconomic Impacts: It can provide valuable insights especially that it may create a potential job creation, skill development, and economic opportunities and studying the implications for public transportation, ride-sharing services, and urban planning can contribute to sustainable mobility solutions.

• Comparative Studies: Conducting comparative studies between emerging countries can identify best practices, lessons learned, and contextual factors influencing EV adoption.

3. Conclusion

According to several studies, without change in technology development level of a country (Dinda, 2005), economic growth will result significant raise of air pollution and environmental impacts (Brock and Taylor, 2010). To achieve economic growth, there is tendency during industrialization process to move from agricultural to more heavy industries that resulted in higher emissions. However, there is a readiness in industrialized countries to move and outsource from polluting heavy sectors, which reduce emissions. Increased demand and consumption patterns for conventional energy resources are a result of economic expansion. Alternative energy sources, such as non-renewable energies, can be taken into consideration as a replacement for fossil fuels in this situation to prevent an increase in pollutants and emissions. At this level, technological advancements might be able to provide approaches to economic growth while solutions like electric cars consider reducing emissions.

(Brock and Taylor, 2010) mentioned, when economies grow and approach a balanced growth path, technical advancements are the main factor reducing emission levels. Thus, tighter pollution restrictions would result in lower pollution levels, more prices, and slower economic growth, but not at a slower rate than it would otherwise. So, as technology develops, pollutant levels go down. If a country like Türkiye does not reach its level of maturity because rate of technical development is too slow to counteract the polluting consequences of rapid economic growth, the EKC hypothesis may not hold true (Ozurk and Yildirim, 2015).

According to (Akbostancı et al., 2009) there is a long run increasing relationship between income and emissions that's do not support EKC hypothesis in data set in Türkiye case. The research shows that relationship between air pollution and income follows the N shape rather than inverse U shape. They justified that in provinces with the lower income, air pollution is higher due to low quality coal and high sulfur content petroleum, old vehicle technology and so on. On the other hand, in medium and upper income provinces due to natural gas, clean heating tools, less pollutant vehicles rates are lower.

As conclusion the economic growth cannot be considered simply as a weapon against emissions and the theory is valid for some countries during periods of time. Raising per capita income or even people's awareness and environmental concerning are not enough to evens to decrease carbon emissions and policymakers need to find specific local and global policies for this battle

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