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THE EUROPEAN UNION'S EURO 1 TO EURO 6 PROGRAMME: STRATEGIES, IMPACTS, AND CHALLENGES FOR EUROPEAN CAR MANUFACTURERS

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Abstract: This article explores labor market opportunities for traditional medical practitioners in the context of Government Regulation Number 103 of 2014. The research examines the continued relevance of traditional health practices in maintaining physical health, particularly during the COVID-19 pandemic. The study highlights that many individuals seek to preserve their health through natural remedies, such as herbal medicines, and often consult traditional healers for conditions like fever, flu, and cough—symptoms that may resemble those of COVID-19, but not necessarily indicate infection. Despite the growing prominence of modern healthcare, the findings suggest that traditional medicine remains highly valued by the community, with significant demand for services provided by traditional practitioners. This demand persists even in the face of regulatory frameworks aimed at formalizing and standardizing healthcare practices. The study concludes that while government regulation has provided some structure to the traditional health sector, the labor market for traditional medical practitioners continues to thrive, underscoring the resilience and enduring importance of traditional health services within the broader healthcare system.

Keywords: Carbon Emissions, European Union, Automotive Industry

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INTRODUCTION

The implementation of Euro 6 emission standards represents a significant effort by the European Union to mitigate the environmental and public health impacts of air pollution caused by road transport. These regulations, which primarily target the reduction of nitrogen oxides (NOx) and particulate matter (PM), have catalyzed technological innovations and stringent compliance measures within the automotive industry. However, despite the substantial improvements in reducing vehicle emissions, the real-world effectiveness of Euro 6 technologies is often challenged by complex factors such as environmental conditions, vehicle type, and the increasing sophistication of regulatory standards.

One of the primary hurdles in achieving Euro 6 compliance is ensuring that vehicles consistently meet the NOx limits under various real-world conditions. Research by Suárez-Bertoa et al. (2021) provides valuable insights into this issue, presenting a detailed analysis of on-road emissions from Euro 6d-TEMP passenger cars operating on Alpine routes during winter months. Their findings underscore the difficulties manufacturers face in meeting the stringent NOx emission limits under diverse environmental conditions, particularly in colder climates where vehicle systems may not perform optimally. This is further highlighted by Suárez-Bertoa and Astorga (2018), who examine the impact of cold temperatures on Euro 6 passenger car emissions, showing that colder environments exacerbate emissions and reduce the efficiency of emission control systems. These studies collectively emphasize the challenge of ensuring compliance across a range of climatic conditions, which complicates the transition to cleaner technologies.

Another critical issue is the adaptation of existing vehicle fleets to comply with evolving emission standards. Retrofitting older vehicles, such as Euro 5 vehicles, has emerged as a potential solution to meet Euro 6 requirements without the need for complete vehicle replacement. Giechaskiel et al. (2018) investigate the retrofitting of Euro 5 vehicles to comply with Euro 6 emissions limits, exploring both the technical feasibility and regulatory implications of such measures. Their research highlights the challenges of adapting older engines to meet modern emission standards, particularly the limitations of retrofitting technologies such as particulate filters and selective catalytic reduction (SCR) systems. In this context, Weiss and Scherer (2021) examine broader technological innovation trajectories, specifically within the internal combustion engine (ICE) sector, and the ongoing adaptation of technological systems in response to the evolving regulatory landscape. This work provides a comprehensive understanding of the systemic challenges that manufacturers encounter as they attempt to transition from traditional ICE technology to cleaner alternatives in compliance with Euro 6 regulations.

Selective catalytic reduction (SCR) systems, which are critical for reducing NOx emissions in diesel-powered vehicles, represent another technological challenge. Shahariar and Lim (2018) delve into the technical complexities associated with SCR systems, particularly in relation to urea-water solution spray-wall impingement and the formation of solid deposits, which can reduce the efficiency and reliability of these systems. These findings underscore the importance of maintaining optimal functioning of SCR systems to ensure that Euro 6 NOx limits are met consistently across all operational conditions.

Moreover, the effectiveness of current aftertreatment technologies in real-world conditions has been further assessed by Valverde and Giechaskiel (2020), who evaluate the emissions of Euro 6d-Temp diesel vehicles over extended driving distances, including multiple diesel particulate filter (DPF) regenerations. Their research highlights the capacity of modern aftertreatment systems to reduce both gaseous and particulate emissions, but also emphasizes that their performance is highly dependent on driving conditions and the implementation of proper maintenance protocols. However, even with advanced technologies, non-compliance remains an issue, particularly with the illegal tampering of emission control systems. Giechaskiel et al. (2022) shed light on the widespread impact of tampering, which not only undermines the environmental benefits of these technologies but also poses a significant regulatory challenge. This issue is further explored by Rešetar et al. (2024), who estimate the NOx emissions from Euro 6 diesel vehicles with manipulated emission control systems, revealing the substantial impact of such tampering on vehicle emissions and highlighting the difficulties manufacturers face in ensuring compliance.

In addition to these challenges, the role of NOx aftertreatment technologies in meeting Euro 6 standards has been extensively reviewed by Selleri et al. (2021), who provide an in-depth analysis of various lean exhaust deNOx technologies. Their review discusses the latest developments in catalytic converters and urea-SCR systems, evaluating their role in mitigating NOx emissions in both real-world and laboratory settings. Their findings underscore the importance of these technologies in meeting stringent emission limits, yet also point to the need for continuous innovation to overcome inherent limitations such as system durability and efficiency under varying operating conditions.

Finally, the assessment of CO2 and NOx emissions from Euro 6 vehicles in both real-world and laboratory testing conditions, as conducted by Dimaratos et al. (2019), provides an important perspective on the effectiveness of emission reduction technologies in practice. Their study of diesel and bi-fuel gasoline/CNG vehicles illustrates the complexities of emissions under real-world driving conditions, emphasizing the need for ongoing improvements in both testing protocols and vehicle technologies to better reflect the true environmental impact of vehicles.

These studies highlight the multifaceted challenges that manufacturers face in meeting Euro 6 emissions standards and underscore the critical role of technological innovation, regulatory frameworks, and environmental conditions in shaping the future of road transport emissions. As the automotive industry continues to evolve, ongoing research and adaptation will be essential to achieving the EU's ambitious air quality and climate goals.

METHOD

This study employs a mixed-methods research design, integrating both qualitative and quantitative approaches to offer a comprehensive understanding of the research problem. Mixed methods research, as defined by Johnson (2014), involves the intentional combination of qualitative and quantitative data collection, analysis, and inferential techniques within a single study or series of studies. This approach enhances the depth and breadth of understanding by leveraging the strengths of both research paradigms, providing a more nuanced perspective on the issues under investigation.

The framework proposed by Creswell and Plano Clark (2017) is adopted to structure the mixed methods design in this research. Their work is a foundational guide in the field, emphasizing a systematic approach to data integration and the development of mixed methods studies. According to Creswell (2021), the combination of qualitative and quantitative methods allows for a more robust exploration of complex research questions. This research follows an exploratory sequential design, which begins with the qualitative phase to gather initial insights, followed by the development of a quantitative phase based on those qualitative findings. The qualitative phase provides the foundation for designing subsequent quantitative instruments or surveys, ensuring that the research instruments are informed by real-world experiences and perspectives gathered in the earlier stage. The integration of qualitative and quantitative data occurs after the quantitative analysis, allowing for a deeper interpretation of the results.

In the initial qualitative phase, data are collected through semi-structured interviews and focus groups. These methods are used to explore participants' attitudes, experiences, and perceptions in depth, facilitating the identification of key themes and variables that will inform the quantitative phase. This stage is essential for understanding the underlying factors and context of the research problem, particularly when exploring new or under-researched topics. The qualitative data will be analyzed using thematic analysis, a method that involves identifying and interpreting patterns within the data to extract meaningful insights.

Following the qualitative phase, the findings will guide the development of quantitative research instruments, such as surveys or structured questionnaires, which are designed to test and quantify the themes identified in the qualitative data. The quantitative phase will involve a larger sample size to ensure generalizability of the results, and statistical analyses, including descriptive and inferential techniques, will be used to examine the relationships between key variables. This phase aims to test the hypotheses formed in the qualitative stage and provide a broader understanding of the trends and patterns identified in the first phase.

Ethical considerations in this research are of paramount importance. Informed consent will be obtained from all participants, ensuring that they understand the purpose of the study, the procedures involved, and their right to confidentiality. All data will be anonymized to protect participant privacy, and the research will adhere to ethical guidelines regarding the responsible handling of data. This will include secure storage of sensitive information and ensuring that participants can withdraw from the study at any time without consequence.

The research process follows a structured chronological approach, beginning with the qualitative phase, followed by the development and implementation of the quantitative phase. The procedure is outlined as follows:

1. Qualitative Data Collection: Semi-structured interviews and focus groups will be conducted to explore participants' views and experiences.
2. Data Analysis (Qualitative): Thematic analysis will be applied to identify key themes and insights.
3. Development of Quantitative Instruments: Based on qualitative findings, a survey or questionnaire will be designed.
4. Quantitative Data Collection: A survey will be administered to a larger sample, and statistical methods will be used to analyze the data.
5. Data Integration: The qualitative and quantitative results will be integrated to provide a comprehensive understanding of the research problem.

Additionally, a documentary study or literature review will be conducted as part of the data collection process. This phase involves gathering, evaluating, and integrating existing written sources, such as books, journal articles, and reports, to build a strong theoretical framework for the research. The literature review will help identify gaps in current knowledge, inform the development of the research questions, and guide the selection of appropriate research methodologies. Library research is particularly valuable for its cost-effectiveness and time efficiency, as it allows researchers to access a wide range of relevant sources without the need for primary data collection from respondents (**Zed**, 2008).

RESULT AND DISCUSSION

The Strategies of the EU in Regulating Emissions from Passenger Cars

The European Union (EU) has long been at the forefront of global efforts to reduce greenhouse gas emissions, especially in the transport sector, which plays a critical role in climate change. Central to these efforts have been the introduction of a series of progressively stringent emission regulations targeting the automotive industry. These regulations, known as the *Euro standards*, have been instrumental in setting emission limits for newly manufactured passenger cars, ensuring that vehicle production aligns with the EU's broader environmental goals. Notably, the Euro 1 standard, introduced in 1992, laid the foundation by setting exhaust emission limits and encouraging the adoption of technologies such as catalytic converters to minimize vehicle emissions (Tzamkiozis, Ntziachristios, & Samaras, 2010).

The Evolution of EU Emission Regulations

The 2000s saw a marked intensification of the EU's regulatory framework, driven by escalating concerns over climate change and the transport sector’s substantial contribution to carbon emissions. In response, the EU adopted more stringent CO2 regulations for vehicles, aiming to curb emissions from the automotive sector (Fabienne, 2011). This period was characterized by intense debates, particularly as the automotive industry, particularly in Germany, expressed concerns regarding the feasibility of the ambitious regulatory timelines and required reductions. As a result, the European Commission introduced mechanisms like the *super credit* scheme, which allowed manufacturers to offset emissions from certain vehicles to help them meet the more aggressive standards (Haas & Sander, 2020). Despite these challenges, the EU persisted in its regulatory drive, and the industry has adapted, with advancements in fuel efficiency, engine design, and emission control systems becoming central to vehicle manufacturing strategies.

The Introduction of Euro 7 Emission Standards

As part of its ongoing commitment to environmental sustainability, the EU is introducing the Euro 7 emission standards, which are set to take effect in 2025. Euro 7 regulations represent a significant step forward in reducing the environmental impact of vehicles. These regulations extend beyond internal combustion engine (ICE) vehicles to include electric and hybrid vehicles, which are often considered “zero-emissions” but still contribute to pollution through non-exhaust emissions like brake dust and tire wear (European Union Council, 2024).

The Euro 7 standards will target reductions in pollutants such as nitrogen oxides (NOx), particulate matter, and carbon monoxide, with a particular emphasis on improving emissions performance during cold starts—an issue of particular concern in urban areas where traffic is heavy and frequent stops occur. By addressing non-exhaust emissions and setting stricter limits on pollutants, the Euro 7 standards represent a holistic approach to reducing vehicle-related air pollution, even for vehicles that do not use fossil fuels.

The Impact of Emission Regulations on the Automotive Industry

The EU’s stringent emission regulations have significantly impacted the automotive industry. Over the last two decades, car manufacturers have had to continuously innovate to meet ever-tightening emissions standards while balancing other consumer demands, such as performance and affordability. This has been particularly evident in the rising demand for high-performance vehicles, with average horsepower increasing from 100 kW in 2001 to 138 kW in 2020 (Sander, 2020). However, with increased engine power comes an increase in vehicle weight, which complicates the ability to meet increasingly strict emission standards. For instance, the average weight of European cars rose from 1333 kg in 2001 to 1401 kg in 2005 (Sander, 2020), reflecting this shift towards more powerful cars.

At the same time, advancements in hybrid and plug-in hybrid electric vehicles (PHEVs) have allowed manufacturers to mitigate the effects of these trends. By combining traditional engines with electric motors, PHEVs can offer improved fuel efficiency and reduced emissions while maintaining high performance. The BMW 330e, for example, reduces CO2 emissions by 44 grams per kilometer and achieves 1.9 liters per 100 kilometers in the New European Driving Cycle (NEDC) test system, demonstrating the effectiveness of hybrid technology in reducing environmental impact (Woolsgrove, 2023). However, the addition of hybrid systems can increase a vehicle's weight, as seen with the BMW 330e's 160 kg weight increase, underscoring the inherent trade-offs between performance, efficiency, and vehicle mass.

The EU's emission regulations have had a profound influence on the automotive industry, driving technological innovation and requiring manufacturers to balance performance, efficiency, and weight in their designs. From the introduction of the Euro 1 standard in 1992 to the upcoming Euro 7 regulations, the EU has consistently sought to reduce the environmental impact of passenger cars. As these regulations become even more stringent with the Euro 7 standards, the industry will continue to evolve, particularly through innovations in hybrid and electric technologies. The challenge of meeting stricter standards while maintaining consumer demand for powerful, high-performance vehicles will remain a key issue for the industry, shaping the future of European automobiles.

CONCLUSION

The European Union's ambitious program to limit carbon emissions from Internal Combustion Engine (ICE) vehicles is a significant step toward achieving carbon neutrality by 2050. The shift from Euro 1 to Euro 6 standards has driven innovation, encouraging the transition to hybrid and electric technologies. This program not only impacts the automotive industry but also positions the EU as a global leader in carbon reduction. These regulations have proven effective in steering manufacturers toward producing more eco-friendly vehicles. However, challenges remain, such as technological adaptation, higher production costs, and evolving consumer preferences.

Looking ahead, the Euro 7 standards are expected to introduce even more stringent limits on pollutants, influencing car design further. While the transition to electric and hybrid vehicles offers substantial environmental benefits, the increasing size and weight of these vehicles might present new challenges, including potential inefficiencies in energy use and environmental impact. This issue highlights a critical paradox: as the weight and power of vehicles rise, achieving greater environmental benefits becomes more complex. Thus, as noted in the *Results and Discussion* section, manufacturers will need to innovate not only in terms of emissions but also in addressing vehicle weight and performance efficiency.

In the broader context of future research, there is great potential to explore more sustainable solutions to mitigate the impact of increasing vehicle weight. Future studies could delve into novel materials, advanced battery technologies, and innovations in vehicle design that balance emissions reduction with performance efficiency. The continued collaboration between governments, manufacturers, and researchers will be vital in overcoming the barriers to a truly sustainable automotive industry. This cooperation will help ensure that the development of new technologies aligns with the overarching goal of reducing carbon emissions and promoting environmental sustainability, while also ensuring that vehicles remain accessible to the general public.

Ultimately, the EU's regulatory framework is paving the way for a cleaner, more sustainable automotive future, but its success will rely on continuous adaptation and innovation across all levels of the industry.

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