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Analyzing the Impact of Transportation Policies on Environment in the United Kingdom

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Abstract

The research represents a qualitative analysis of secondary data to explore the effectiveness of UK transportation policies in minimizing the adverse affects of transportation system. Using thematic analysis as the primary methodological approach, the study examines the state of the art polices of UK to find out whether they are reducing the emission of gases from transportation sector that are harmful for human health and biodiversity. The main objective of the study is to analyze different policies of the UK government such as clean Air Strategy and Decarbonization and determine how it is helping in improving environment and reducing pollution. The available literature lacks in formulating and designing a robust framework that can provide holistic evaluation of policies. Statistical analysis suffered from unavailability of large and diverse data set that can cover different impacts and regions thus could not provide comprehensive evaluation of the policies. The academic literature also lacks a systematic survey of UK current transportation polices that can help to evaluate or summarize its various dimensions. Using thematic analysis on data from UK government websites and reports, different key weaknesses were derived from the policies that can be used as variables or dimensions in devising a framework or statistical model for more rigorous analysis or evaluation of policies. The thematic analysis resulted in various key themes and sub themes such as improving monitoring and evaluation of policies, stakeholder management and engagement in policies active transportation combined in public transport and use of land based planning in minimizing distances between locations. Different recommendations are devised that can help future researchers to perform more detailed survey research. Moreover the research analyses the policies that merged as part of Climate change Agreement and current literature has not yet analyzed in detail. The result provides foundation for future qualitative and quantitative research in the same area.

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Chapter 1: Introduction

Transportation not only helps to move around but also is a source of building prosperity. Without effective transportation system in a region, access to healthcare, job and education will become difficult (Shah et al., 2021). However, it also has a negative side that is the environmental impact. According to statistics given in (Fan et al., 2023), it is the second-largest emitter of carbon in the world. There are many effects of transportationon the human and its environment. This includes effects on biodiversity and habitat loss, causing air pollutionand contributing to greenhouse gases and climate change, and noise pollution (Creutzig, 2015). Due to this impactenvironmental sustainability is one of the important areas for government, researchers and stakeholders to focus on (Shah et al., 2021).

Government and policy makers understandthe environmental implications of transportation system and make informed decisions and developing policies accordingly (Karjalainen & Juhola, 2021). These policies aim to reduce the impact and negative sides' different transportation activities (Karjalainen & Juhola, 2021). The design of effective policies according to latest technology and mechanism not only results in improving transport infrastructure but also improves the environmental impact. The policies can be related to different domains and categories such as technology improvement, restriction on use of old vehicles, providing financial benefits to public to use advance vehicles and improving public transport by adopting environment friendly technology (Velasco Arevalo & Gerike, 2023).

UK is selected for this thesis due to several reasons. It has a well developed infrastructure including air, rail and land transport (GOV.UK, 2021). However, it still lags behind in achieving sustainability goals when compared to other European countries. According to sustainability achievement report, UK shows little progress in achieving clean environment goals (Sustainable development report 2023, 2023). It has several policies and interventions that are aimed to achieve the sustainability goals in case of transportation. These include lowering greenhouse gas emissions and improving air quality (Poynting, 2024). Finally, the UK's political and regulatory system makes it an ideal environment for researching the implementation and effectiveness of transportation policy (Antonini, 2021). Different industry reports will provide significant insights for other regions facing comparable challenges. Examining transportation policies in the United Kingdom can result in significant recommendations. This can help in devising best practices for increasing environmental sustainability in transportation not only in UK but around the world.

1.1 Statement of the Problem

Transportation is one of the most important facilities that public needs to fulfill their daily need and tasks(Butt et al., 2022). However, it comes with many effects particularly on environment. It has negative impacts on human health and overall ecosystem due to gas emissions that leads to problems like climate change. Therefore, governments around the world keep designing and implementing policies and procedure that minimizes the effects of transportation. UK has adopted multiple policies including complete electrification ofdomestic vehicle by 2050 and introduction of other related technologies to minimize environmental effects. However, there are still pollutants in air that keeps on increasing(Butt et al., 2022).

The topic is important in the context of UK green environment as it will analyze its transportation policies and find gaps. The identification can help various stakeholders to analyze and evaluate the policies deeply leading to design and implementation of more effective policies. The academic literature also shows lack of detailed evaluation in this respect. Thus, an analysis of transportation policies is required to ensure the attempts are sufficient to reduce environmental damage in UK and help it achieve its sustainability goals.

1.2 Research Objectives

Following are elaborated objectives of the research:

1. Analysis of the environmental impact of transportation: Through academic research and taking information from industry reports, the objective will seek to provide a thorough analysis of the environmental impact of transportation globally. It will provide overview how transportation system leads to environmental degradation.

2. Research and Analyze Policy Effectiveness: A comprehensive research will be carried out to analyze the transportation policies in UK. Academic sources and UK government publications will be used to determine the implementation and any success of these polices. It will analyze how different types of policies are implemented to reduce the environmental impact. In this section different keywords and themes will be extracted out for making recommendations.

3. Recommendations for Enhancing Sustainability: This objective seeks to make suggestions for improving the sustainability of the UK's transportation systems based on the analysis's findings. These suggestions will be derived from the case studies of successful countries that have reached or near to

reach their environmental target goals such as Switzerland. The study aims to facilitate the resolution of environmental issues related to transportation in the United Kingdom by converting research findings into practical suggestions.

1.3 Research Questions

Based on research objectives defined following research questions will be answered in this thesis:

RQ1: How do transportation policies in UK address environmental sustainability?

RQ2: What are the key factors identified in the literature that influences different policies effectiveness? Are these factors included in UK policies design?

RQ3: What policies are adopted by countries leading the clean environment list?

RQ4: What recommendations can be proposed for enhancing the sustainability of transportation systems in the UK based on the findings of the analysis?

1.4 Scope and Limitations

The study will analyze transportation policies' environmental impact across the UK that is how these policies can be improved to minimize the negative impacts on environment. It particularlyfocuses on domestic land based transport system. The research method will use only secondary sources find literature gap and provide recommendation that can improve UK policies. These recommendations will be related to improving policies as adopted by other countries that have surpassed UK in achieving environmental goals. Inclusion of primary data collection can further enhance the results and recommendations; however, current research will focus on secondary data only.

1.5 Structure of the Thesis

The report will be divided into five chapters. The introduction chapter elaborates on importance and significance of the topic highlighting the reason why the particular geographic location is selected for the research. It will also summarize the scope and limitations of the research. The literature review chapter will summarize related literature, identifying the research gap. It will set context for discussion and recommendation section of the document. The methodology chapter will elaborate on whole research process covering the thematic process and paper selection from various databases.

1.6 Summary and Conclusion

The chapter introduced the topic, its significance and its limitations. The research is important because it will provide an overview of environmental impacts on UK transportation system and how effective can the policies be made to minimize environmental effects. It will help to identify the shortcomings of policies and help different stakeholders to plan more effective policies to mitigatedifferent risks of transportation system side effects.

2. Literature Review

Statistics from 2017-2022 and national surveys of UK environmental conditions show that more greenhouse gases were released by the UK's transportation industry than by any other industry (Netov & Lomev, 2022). However, there is seen yearly decrease in emissions but the reason highlighted for this decrease is mainly due to UK switchingfrom coal to gas as its main energy source that is improvement in environmental degradation is due to decreased emissions from energy production (Netov & Lomev, 2022). Comprehensive research on the environmental impact of transportation is significant because UK is lagging behind many other developed European countries in reducing carbon emission and air pollution. This is also indicated by the provisional data released by DESNZ (UK government statistics) for the UK's domestic greenhouse gas (GHG) emissions. Despite many policies and agreement in place like Paris agreement, the transport sector in UK during year 2022, showed 3.8% increase to 112.5 MtCO2e (Transport and environment statistics 2023, 2023). This rise in emissions signifies a concerning trend that demands urgent attention and effective mitigation strategies. This research will help in understanding the underlying factors driving these emissions, analyzing existing policies, and formulating recommendations to minimize transportation-related carbon emissions and promote environmental sustainability.

UK has implemented several policies that reflect the UK government's efforts to tackle transport emissions, mitigate climate change, and improve air quality through a combination of regulatory measures, incentives, and investments in sustainable transportation infrastructure and technologies (UK Territorial Greenhouse Gas Emissions National Statistics, 2021). Main UK policies on transport emissions include the Clean Air Strategy, Road to Zero Strategy, and the Ultra Low Emission Zone (Decarbonization Strategies). However, UK' emission policies haven't met pollution targets. Relying solely on them doesn't cut emissions due to diesel industry opposition. Integrating policies with stricter regulations, real-world emissions testing, and public transport investment can enhance effectiveness (UK Territorial

Greenhouse Gas Emissions National Statistics, 2021), and help it come in the list of countries with best emission policies (Countries leading the way in climate policy, 2021).

2.1 Impact of Transportation on Environment

Following are the impacts of transportation services/system on environment worldwide:

1. Greenhouse Gas Emissions: Greenhouse gases include Methane (CH4), nitrous oxide (N2O), and carbon dioxide (CO2. Theseare considered as fossil fuels in automobiles and are the major source of greenhouse gas emissions. In UK, land Vehicle emissions are a major contributor to climate change and global warming caused due to greenhouse gas emissions. It also causes other negativeenvironmental effects, such as sea level rise, temperature rise, and extreme weather occurrences. According to Lera-López et al. (2014), these variables also have significant effects on environment and human health.

2. Air Pollution: Vehicles emit pollutants such as NOx, PM, SO2, and VOCs into the environment. These pollutants contribute to poor air quality, smog formation, respiratory ailments, and cardiovascular diseases, which have an influence on both human health and the environment. These contaminants also harm crops and ecosystems. They also contribute significantly to the creation of ground-level ozone, a major component of urban smog. Efforts to reduce air pollution from transportation include encouraging cleaner fuels, increasing vehicle efficiency, and investing in public transit and active transportation infrastructure (Manisalidis et al. 2020).

3. Noise Pollution: Vehicle creates noise pollution, due to engines and tire friction. Due to this reason, transportation has significant impact on urban noise levels. Continuous exposures to high noise levels cancause many health issues like hearing loss and stress. Communities near busy roads or highways are particularly affected by this type of pollution. To minimize its effects developed countries often install sound barriers along highways, using quiet pavement technology. Electric vehicles are also form of mitigation for noise pollution. Therefore, policies related to minimizing noise pollution effects can help citizens live in peaceful environment specifically people living near heavy traffic areas. (Gilani & Mir, 2021).

4. Effect on Habitat: Transportation infrastructure, such as roads and railroads, has the potential to damage natural ecosystems, disrupting animal corridors and migration patterns. Habitat fragmentation isolates animal populations, reducing their access to food and adequate habitats. This can result in genetic isolation and reduced biodiversity. The construction and maintenance of transportation

infrastructure can cause habitat degradation, worsening the impact on animals. To reduce these effects, many countries implement strategies for wildlife crossings such as underpasses and overpasses are built to allow animals to travel safely across roadways and railways.

2.2 UK Transportation Policies

2.2.1 The Paris Agreement

UK is one of the member countries of The Paris Agreement. This agreement was established in 2015 at the 21st session of the Conference of Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC). It is a global treaty aiming at fighting climate change. Its main purpose is to reduce greenhouse gas emissions. It sets ambitious goals to limit global warming to well below 2 degrees Celsius above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5 degrees Celsius It aims to keep global warming below 2°C and aspire to limit it to 1.5°C by committing both developed and developing countries to reduce greenhouse gas emissions. Furthermore, it sets a long-term goal of achieving net zero emissions, necessitating a complete decarbonization of sectors such as transportation. Despite the withdrawal of the United States from the agreement, the commitment of other nation's remains strong, that indicates continued support for the Agreement's objectives. The Paris Agreement is an important and beneficial step towards addressing climate change. However, there is a lack of sufficient evaluation metrics and the need for effective policy measures to promote clean technologies (Parry, 2021).

The Paris Agreement alone cannot completely prevent temperatures from rising beyond 2 degrees Celsius, as many countries are unable to reach the target. However, still it is believed to make the emission reduce (Parry, 2021). There are different commitments under the agreement. The participating countries need to make clean technologies more affordable by using taxes and subsidies. The second agreement is to support research on clean technologies, and accordingly invest in clean infrastructure. They are also required to introduce regulations to reduce carbon emissions across all parts of the economy, including transportation (Parry, 2021). UK has related policies like Decarbonization policy to boost its struggle towards clean environment.

To summarize, the main aim of Paris agreement is to address the climate change. As transportation sector is one of the main sector that affects the climate, its policies can be shaped by the emissions goals and targets set in the agreement. As UK is part of the agreement, following the agreement parts can help it build climate resilient country.

2.2.2 Transportation Policies

Following are technology based policies and methods introduced by UK government to minimize effects of transportation on environment:

1. Clean Air Zones Strategy: Clean Air Zones have been implemented in several cities across the UK to reduce air pollution caused by vehicles. These zones typically charge or restrict access to high-polluting vehicles, encouraging the use of cleaner alternatives (Department for Transport:UK, 2019).
2. Vehicle Excise Duty (VED): The UK government has introduced a graduated Vehicle Excise Duty, commonly known as road tax, which incentivizes the purchase of low-emission vehicles by offering lower tax rates for vehicles with lower CO2 emissions (Vehicle excise duty, 2023).
3. Plug-In Car Grant: This government scheme provides financial incentives for individuals and businesses to purchase electric vehicles (EVs) and plug-in hybrid vehicles (PHEVs), thus promoting the adoption of cleaner transportation options (Manager, 2023).
4. Policies for Renewable energy: Though these policies, the U government provides incentives and funding to promote renewable energy sources. For example wind, solar system, and biomass. The purpose is to reduce dependence on fossil fuels and lower carbon emissions. Electric automobiles and trams run on sustainable energy since they are powered by solar technology.
5. Polices for maintaining Carbon Pricing : The UK government has established carbon pricing mechanisms, including Carbon Price Support and the EU Emissions Trading System (ETS). The purpose is to encourage sectors to cut emissions and invest in cleaner technology.
6. Low Emission Zones (LEZs): Many countries including UK promote Low Emission Zones charge by putting ban vehicles that do not meet emissions regulations. This leads to the adoption of low-emission vehicles (Department for Transport: UK, 2019).
7. Investments in public transportation infrastructure and services aim to minimize reliance on private cars, reduce traffic congestion, and lower emissions. Public transportation fosters more sustainable travel patterns by providing easy and economical alternatives like buses, trains, and trams. Increased access to public transit can also improve mobility in underserved communities, supporting social fairness.
8. Active Transportation: Promoting and encouraging cycling and walking also helps in reducing impacts of transportation on environment. UK has multiple policies that can motivate individuals to minimize use of private cars.Such policies include banning cars from main cities to

work areas by improving and introducing public transport, and facilities of green spaces for enjoyable walking and cycling. In England, department of transport has responsibility of designing the policy by setting the aims and objectives of increasing active travel in England. It includes funding polices and integration with future expansion in public transport that minimize the use of vehicles and promote walking as benefit for both human health and environmental side effects (National Travel Survey 2021, 2022).

UK has implemented aforementioned policies to cover a range of measures aimed at minimizing different negative impacts on environmental such as air pollution, carbon emissions, and energy consumption. This also covers the goal of promoting sustainability cities and fighting climate change challenges.

2.3 Critical Review of Impact of Existing policies in UK

This section is a critical review that tries to assess past research publications on this issue in order to identify gaps in the literature and create a course for future study.

The Multi-level perspective Framework:(Geels, 2012) employed a social and technical strategy to analyze various policies related to reducing environmental impact in UK and Netherlands. The research particularly put emphasis on initiatives related to reduction of carbon.The author has used a multi level perspective framework consisting of domains' like industry, technology, markets, policy, culture, and civil society. This multi-level perspective (MLP) framework helped in analyzing different mechanism that is used to reduce carbon transitions in the transport systems by adopting new technologies in all sectors including transport sector. The framework selected by the researchers focused on analyzing the transitions from traditional systems to technological invention covering social economic dynamics also (Geels, 2012). However, the study did not cover the role of polices in implementing or shaping the new transport systems. Policies are essential for making the new transition successful. Therefore, the framework lacks the additional methodologies or analysis that should include policies role in successful implementation. A thorough and well designedmethodology was outlined in the paper; however the practical implementation of this framework for evaluating the environmental impact of transportation policies in the UK is not available and evident from current research.Researchers emphasize on use of multi domain considerations such as social, economic and environmental in designing the policies (Schröder & Klinger, 2024). Researchers have argued that it is essential to find trends and key metrics for

measuring effectiveness and sustainability of policies, to make the assessments more diverse and fair (Li & Xeng, 2020; Karjalainen & Juhola, 2021).

Green Technology and improvement of Regulatory Framework: Shah et al., 2021 have analyzed polices related to use of Green technology. Green technology policies include a set of eco-friendly vehicles, renewable energy, and sustainable infrastructure thatreduces transportation's environmental impact. These policies include Government incentives like subsidies for public and imposing different regulations. The policy helps in encouraging green technology adoption, facilitating a shift to cleaner transportation and emission reduction, thus promoting environmental sustainability (Shah et al., 2021).However, the research has identified policy and regulatory challenge as one of the main barriers in implementing such advance transport systems. According to them policies implementation face challenges of cost, trust and scalability. The polices must include frameworks that cover the challenges of urban planning, limited infrastructure, emission regulations, and other efficiency standards (Shah, 2021). They formulated a three-step strategy (ASI strategy) analysis framework for determining methods to overcome challenges and barriers to green transportation implementation. However, it does not provided detailed information on the methodology used to identify or evaluate this strategy's effectiveness. Thereresearch also shows lack of empirical evidence or rigorous analysis supporting the proposed approach.

Preference of Non-GHG gas reduction: Another research by (Lott et al., 2017) suggest implementing policies related to non-GHG air pollutants when considering technology transitions for decarburization goals in the energy sector. They suggested that Non-GHG (Greenhouse Gas) air pollutants, such as particulate matter and nitrogen oxides, can be reduced through transportation implementing stricter emissions standards. As compared to other policies it results in cleaner air, and improved public health, thus contributing to overall sustainability and well-being(Lott et al., 2017). This will overcome the challenges of implementing green technology that requires more cost and advance infrastructure. Frame work by (Lott et al., 2017), was more comprehensive but didn’t cover transportation area in detail and generally analyzed policies for reducing air pollution from multiple industry including transport.

Evaluating Negative side of Electrification using Mathematical Model: Electric vehicles powered by sustainable and renewable energy can achieve emission-free and climate-neutral operation, advancing electro mobility goals locally, nationally, and globally. Pietrzak, 2020 research shows the negative side of replacing conventional buses with electric vehicles in some European cities. Through electric vehicles

both cars and trains/trams can reduce urban pollution, it may shift pollution geographically. The introduction of electric vehicles in public and private transport will result in bringing changes in traffic patterns, energy production for electric vehicles, or other indirect effects of the policy implementation. It will also raise need to utilize alternative energy sources. Thus, a comprehensive approach is necessary to mitigate negative environmental impacts and promote sustainable transportation.

The authors also conducted a combination of qualitative and mathematical model using air quality monitoring data to evaluate the effectiveness of policies such as low emission zones and congestion charging schemes. While the study provided valuable insights into the short-term effects of these policies on air pollution levels, the limited mathematical model lacked a long-term perspective on their sustainability and broader environmental impacts. Moreover, the data collected was of limited scope and didn't include diverse regions which can give different results when applied to other UK regions also.

Promotion of Active Transportation: Findings by Glazener & Khreis, 2019 investigate policies like active transportation that have many positive impacts on environment to reduce the pollution. Active transportation means banning cars from city centers and investing in pedestrian and cycling infrastructure. However, according to the authors many policies are deficient in providing the integration of these approaches into comprehensive, holistic strategies. Another research also highlights that these are one of the important methods or efforts to improve air quality often focus on reducing emissions from vehicles. Problems occur when analyzing their combined and separate benefits. Conflicts could arise if, for example, efforts to reduce emissions from vehicles through clean air initiatives contradict policies aimed at promoting active transportation. Conversely, synergies may occur if these initiatives complement each other, such as when promoting cycling and walking helps reduce vehicle emissions and improve air quality (lazener& Khreis, 2019).The research lacks the detailed and comprehensive examination of the synergies and trade-offs between clean air initiatives and active transportation promotion. Thus, this leaves room for more research on this topic for effective analysis and evaluation of existing policies. Moreover, in England and many parts of UK, the active travel policies are still in design and audit phase. Its complete implementation is still pending (Active travel England, 2023).

Statistical Analysis of Policies: The statistical based research that analyzes the impact of transportation on the environment by examining various policy options for reducing greenhouse gas emissions in urban areasof UK (Winkler et al., 2023). It introduces the Urban Transport Policy Model (UTPM) and uses

London as a case study to assess the effectiveness of policies like electrification, light-weighting, and modal shift. However, it lacks in understanding the severity of actions needed to meet carbon reduction targets at the regional level and suggests the urgent need for more comprehensive and intensive policy measures. It used limited carbon emission data and car related statistics in its model and only pave pathway for more comprehensive and advance future research (Winkler et al., 2023).

2.4 The Research Gap

The critical analysis of research papers related to UK transportation policies evaluates these policies using statistical methods and application of different frameworks. Following research gap is identified after analysis:

1. Each research uses different methodology to provide analysis and effectiveness of policies. Mostly the available current research covers single or related policies only and some are not specific to transportation sector, thus considering environmental impactsfrom different sectors. The policies that are aimed at reducing the environmental impact of transportation, are analyzed from different angles however their discussions shows absence of comprehensive analysis unable to elaborate on how these polices targets and improves carbon emissions, and air quality. No academic research is available on UK current policies that emerged as a result of Paris agreement.
2. The reliability of the statistical results is also not guaranteed for long time as limited data set are used (Winkler et al., 2023). This lack of thorough evaluation and analysis is a potential gap in understanding the effectiveness of existing policies in addressing environmental concerns related to transportation particularly in UK. Moreover, there is limited statistical/quantitative research in this area.
3. Moreover a systematic evaluation is required that assess both the positive and negative impacts of the specific transportation policies in UK. The current literature covers the technological and other advancements while assessing impact while not taking into consideration the specific policies of UK. There is also a lack of Comprehensive Assessment/survey research in current academic literature. The databases used for retrieving research paper didn't result in any detailed survey of all related policies that can help examine the impact in detail.
4. Research on UK policies shows different government policies cover both economic growth and environmental concerns, however, no evaluation shows that how policies are successful in

mitigating risks of environmental harm. A more comprehensive framework is required to assess and evaluate different dimension of policies.

In this thesis, to cover the research gap, the researcher will analyze and assess different UK policies from secondary sources (UK government and policies reports) through thematic analysis in terms of its negative and positive sides. The research will create a base for future work on evaluating transportation policies by identifying weak areas of policies that will help in devisingkey factors. These can be further used to make more robust evaluation of policies using different frameworks and statistical analysis.

2.5 Conclusion

The chapter elaborated on environmental impacts of transportation on environment. Emission from vehicles contributes to greenhouse and air pollution that have adverse affects on human life and biodiversity. The chapter also researched and defines different UK policies that can help reduce the environmental effects of transportation systems. The last part of chapter provided critical evaluation of existing literature on UK policies evaluation and effectiveness. Researchers have used different frameworks and statistical analysis to determine effectiveness but lacks in comprehensive evaluation and requires more accurate and detail data for providing long term sustainable results.

3. Methodology

3.1 Introduction

Methodology is important phase of any research as it highlights what the researcher intends to do and what procedure or set of procedures will be used while completing the research (Kumar, 2019). It allows evaluating the reliability of the research conducted. The chapter will highlight the types of research method used, data collection method and procedure, tools used to conduct the research, and justification of the method and tools used in this project. It will elaborate on the research philosophy to be employed while completing this research.

3.2 The Research Onion

The research Onion was developed by Saunders et al., 2012, and is widely used by the researcher as basis of designing research methodology. As onion has different layers, Research methodology is also based on different layers. Each layer specifies different decision to be taken by the researcher for crafting design methodology. As the researcher moves from outer layer of onion to inner layers, decision

change forms from higher level to lower level that philosophical to practical level. Following is the pictorial view of the research onion by Saunders et al., 2012

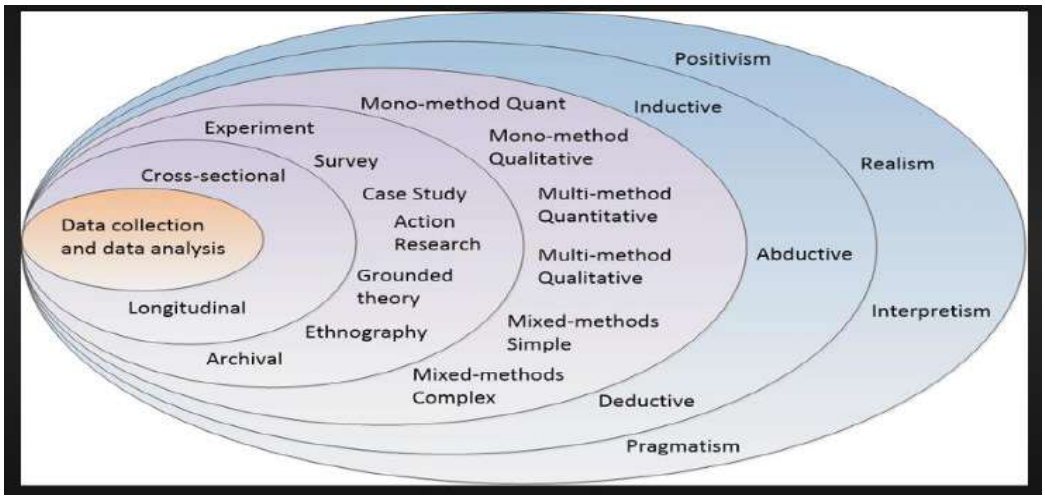

Figure 1 Research Onion by (Saunders et al., 2012)

The remaining chapter will explain each layer of Research Onion as adopted by the researcher.

3.2.1 Philosophy of Research

The following section will explain the framework or structure the researcher followed while completing the different stages of the research. Research philosophy consists of researchers' beliefs, principle, and different elements that guide the whole research process (Saunders et al., 2012). As the researcher moves on the path of acquiring knowledge and inquiry, application of the epistemological and ontological ideas is essential. Epistemological ideas help us in knowing things that is how to make sure that reasoning and knowledge is true (Bridges, 2018). Ontological ideas help to differentiate between what is real and what is artificial. It helps to understand us on what things the world or our concept is build. These ideas means philosophy shape and influences are approach to research, conceptualization, and interpretations as we move forward to complete the research (Saunders et al., 2012). Our research skills and methodology we adopt are based on these philosophy concepts and beliefs. This concept aligns with our goals, objective, ethical concerns and helps us to complete the research with clarity and commitment (TSANG, 2017).

There are two main paradigms of research in philosophy and sociology. These are known as interpretivist and Positivist approach or paradigm (Nickerson, 2024).

Positivist approaches often use quantitative approaches such as primary data collection through questionnaires and surveys because of its advantages. The approach considers quantitative data as more reliable, consistent, representative due to high likelihood, and general in terms of external validity. It emphasizes the use of empirical evidences (Thompson, 2023;Saunders et al., 2012). It consists of testing hypothesis to find relationship between different variables. As research in this case consists of collecting data is collected from secondary sources, this type of approach neither was nor selected by the researchers to carry out the research (Thompson, 2023).

Another type of approach is interpretivist approach. This approach researches other people ideas, thoughts and theories to understand the deeper meaning of the issue or problem of research (Nickerson, 2024). To develop a detailed view of topic researcher explores others narrative, perspective, and frameworks related to the topic and interpret different dimensions (Nickerson, 2024). The researcher selected interpretivist approach this approach emphasizes use of qualitative data and content analysis as required by the research topic selected.

3.2.2 Research Approach

Research approach includes two types of approaches. Deductive and Inductive approach. In deductive approach the researcher starts with a hypothesis and tests the hypothesis using different evidences and techniques. Researcher starts with selecting a framework related to the topic, design different hypothesis, and then collect and analyze data to find the truth of the hypothesis (Johnson, 2015;Tjora, 2018).

Inductive approach starts with observation and collection of data. Different patterns are identified in the collected data and theories and frameworks are devised for further investigation (Johnson, 2015). The researcher starts with collecting data from different secondary sources. These sources included can include surveys, interviews, Government and industry publications and academic research. Different patterns and themes related to effectiveness of existing policies are identified and used in data analysis section to derive recommendations and solutions to more effective policy making (Johnson, 2015). While conducting this research, the researcher used inductive process highlighted in detail in thematic analysis section.

3.2.3 Research Strategy

Research strategy is the third layer of Research Onion. It consists of selecting one of the types of study to conduct the research. There are different types for example Experimental research, Action research,

Case study research, Grounded theory, Ethnography, and Archival research. The research strategy adopted by the researcher was Archival strategy. An archival research strategy uses content and materials from already published research, data sets, and other publications, that is it draws insights and arguments through a review of this existing data. The archival strategy is closely linked to qualitative analysis as adopted by the researchers in this case (Flick, 2018). For this purpose, design of research question is required. Following are different types of research questions (Flick, 2018):

1. Descriptive Research Questions: The descriptive question answers a phenomenon or situation. For example why a particular disease spreads fast in a specific community, and determining characteristics of particular target group.
2. Exploratory question: These questions elaborate on new research area, or answer a hypothesis. For example determining the outcomes of particular examination system.
3. Explanatory Question: The research aim is basically to derive relationship between different variables. For instance why a particular factor results in employee poor performance.
4. Predictive question: The research determines trends and outcomes in a set of data.
5. Evaluative Research Question: The aim of evaluative questions is to evaluate the effectiveness of a particular event, policy, or programs. For example what is impact of digital resource utilization in classroom on student learning?

The research questions designed in thesis are evaluative in nature. The purpose is to evaluate the effectiveness of transportation policies on environment that is policies design to minimize the negative side of pollutants is effective in improving environment of UK or not. Strengths, weaknesses, efficiency and effectiveness of transportation polices of UK on various domain of environment will be analyzed.

After designing evaluative research questions, the researcher using combination of inductive and deductive approach systematically analyzed the qualitative data to identify patterns and themes, using research questions in mind. The first step was to understand different dimension of research questions and collect relevant data. The author made clear the specific aspects and parts of research questions for evaluating different criteria that is analyzing effectiveness or impact of transportation policies. The different stages involved in the methodology are summarized as following:

Data Collection: Secondary Source Search Strategy

Academic paper including journal and conference paper were included for research purpose. Industry reports and government publication for UK and other European countries were also added. The

database used by the researcher for retrieving articles was Google Scholar. Following four step strategies was followed by the scholar for retrieving and selecting articles from Google scholar:

1. The first step was to identify key concepts and terms for search related to the research topic. The main terms/concept were environmental degradation, negative impacts of environment, transportation system, land based transportation system, countries like UK, Britain, Wales, Scotland, and European countries with high SDG score in environment like Finland and Austria.
2. The different combination of search phrases related to the topic where:
    - Transportation impact on Environment
    - Transportation impact on Environment of UK
    - Environmental policies in UK
    - Environmental Policies related to transportation in UK
    - Environmental Policies and transportation in UK
    - Evaluation of transportation polices in UK
    - Analysis of transportation policies in UK
3. Alternative word search included:
    - For Environmental degradation words like effects on pollution, effects on ecological system, damage to these system and environmental harm were used.
    - For Transportation alternative words like land Transport infrastructure/system, mobility system, and transit system in Uk were used
    - For Policies words like laws and Regulations, legislation of UK , governance measures by Uk Government
    - For alternative words related to selected country United Kingdom, Britain, England, Scotland, Wales and North Ireland were used.
4. Boolean operators like OR and AND were used to refine the search strategy.
5. In case of date of publication, 5 years was criteria that are paper older than 2019 were not selected. However, if relevance to the topic was high after examining the abstract, paper was selected. However, this was used for literature review purpose only.
6. Articles were selected based after reviewing abstract and keywords and conclusions.

3.2.4 Thematic Analysis

Thematic analysis is the widely used research technique for analyzing qualitative data. It helps in systematically organizing and analyzing large data sets. Thematic analysis is the search for themes and

codes that can help in understanding the dataset, by careful reading and re-reading of data. This approach can produce credible and reliable findings. Many researchers have pointed that it has no clear procedure and guidance to carry out the thorough thematic analysis; approach designed by Braun and Clarke (2006) is widely used by early researchers. Braun and Clarke (2006) have argued that thematic analysis is theoretical framework that is flexible for any size of research project and data. It can easily analyze qualitative data for exploring ideas and concepts, due to its transparent and easily understandability feature.

Thematic analysis can also be categorized as deductive thematic analysis or inductive thematic analysis (Braun & Clarke, 2006; Fugard et al., 2020). Deductive thematic analysis is theory driven and uses frameworks to search and refine themes while reading through the data. According to Braun and Clarke, deductive approach towards thematic analysis is more structure and allows deep analysis of predefined themes thus helping to test hypothesis with more rigor. On other side is inductive thematic analysis that is a bottom up approach with advantages of providing unexpected themes to emerge. It is flexible as the author is not dependent on predefined codes, and helps in discovering new themes (Fugard et al., 2020). Deductive themes are limited to the researchers' interest and frameworks he is using, normally taken from previous research. However, thematic analysis can employ both types of methods depending upon the research stages the thematic analysis is spread (Fugard et al., 2020;Braun & Clarke, 2022). In order to increase the depth of analysis and generate maximum codes, the author has adopted the inductive approach to thematic analysis. In this case, inductive approach is being utilized while reviewing the policies. This thematic analysis serve to derive large set of inductive codes as the data is being analyzed.

Braun and Clarke 2006, also suggested a framework shown in pictorial form of below for analyzing the data:

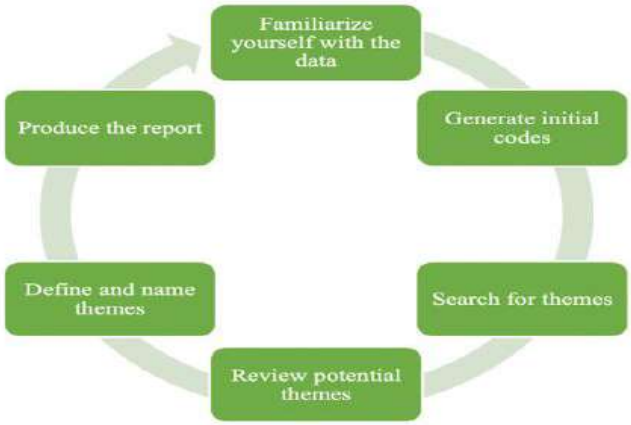

Figure 2 Braun and Clark Thematic Analysis Framework

Step 1: Become familiar with the data: In the first step the data is read thoroughly number of times. It is essential that the researcher must be aware of type and structure of data. The researcher while conducting the first step of thematic analyses, were aware of important parts of research paper to focus on while reading the papers, for instance, methodology, keywords and abstract section. This step was included both in literature review and data

Step 2: Generate initial codes: The second step organizes the data systematically and reduces data giving it different meaning. Different techniques are used at this stage. The researchers employed the techniques of open ended questions here. The process was inductive. Inductive part was due to use of open ended questions that is no pre code existed but codes were modified and re-invented as the text was analyzed.

Step 3: Search for themes: During this stage codes are assigned to different themes. Braun and Clarke highlights that there no set criteria for defining rules for creating themes. Themes in most cases derive from research question or hypothesis, and mostly are dependent upon the researchers' perspective and creativity. Themes were set by the researchers during the data analysis section.

Step 4: Review themes: During this phase the researchers review, modify and develop the preliminary themes that we identified in the previous Step. Normally data at this stage is gathered at on replace related to different themes. Initially word processing softwares were used by researchers for this task. The stage is now easy to complete due to sue of qualitative data analysis tools. The detail of use of tools will be provided in the appendices.

Step 5: Define themes: According to Braun and Clarke the final stage is the refinement of themes. It purposes is to identify the essence of each theme and relate to various sub themes. It also includes analysis of how different themes are related to each other.

Step 6: Write-up: After finalizing themes the last stage is to produce the final report in this case recommendations on how UK can improve their policies.

3.3 Chapter Summary

The chapter elaborated on research method adopted by the author. It was explained in the view of Research Onion by Saunder et al, 2012, which is widely used by the researchers while devising the research methodology. It included both philosophical and practical aspects of conducting the research. The different methods used by the author are interpretivist concepts, combination of inductive and deductive approach using qualitative methods and explanatory research questions, and thematic analysis.

4. Data Analysis

4.1 Introduction

The purpose of the chapter is to represent findings from various secondary sources to analyze the impact of transportation policies on UK environment. Different academic research papers and government documents and statistics were used to analyze the impact of policies. The data analysis chapter aims to identify key themes to make recommendations for effective implementation of transportation policies in UK.

Data collection and preparation was done through scanning all relevant documents that is research papers and government reports related to transportation policy and decarbonization in the UK. Documents were most relevant to the aim and objectives of the study were selected for thematic coding and analysis. The section will cover the analysis of our collected data from different government and academic sources to answer each research questions that guided our study.

4.2 Finding the Impact of Transportation on Environment (RQ1)

The literature reviewed showed that there are two important impacts on environment due to transportation: the Greenhouse Gas emission and Air pollution. In UK, transportation sector was responsible of emitting 99 MtCO2e (million tons of carbon dioxide equivalent) in 2022. However

transportation in UK results in 33% of Nitrogen Oxides (NOX) emissions and 14% of Particulate Matter (PM2.5) emissions that have negative impact on human health (Transport and environment statistics 2022, 2022). There are two types of emissions to be considered in case of transportation impact that are direct emissions produced by the vehicle itself, and indirect emissions produced by the extraction, refining, and transportation of the fuel used to power the vehicle (Transport and environment statistics 2022, 2022).

In UK, transportation sector is at the top to emit highest tons of greenhouse gas in to the environment. It has designed and implemented several strategies to address this problem and help minimize the effects. Expansion of public transport, promotion of strategies to use electric vehicles, infrastructure for Electric trains and trams and regulations for promotion of active transportation are the most common mechanisms to reduce transportation burden on the environment. Following are the statistics derived from government reports which helped in analyzing the impact of such policies:

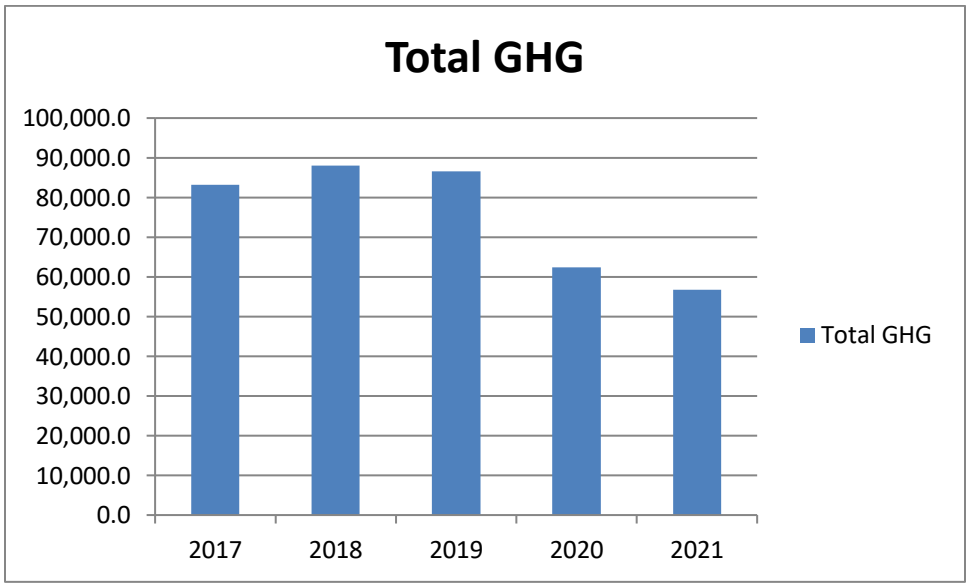

Figure 3Green house Gas Emission (million tons of carbon dioxide equivalent) from 2017-2021

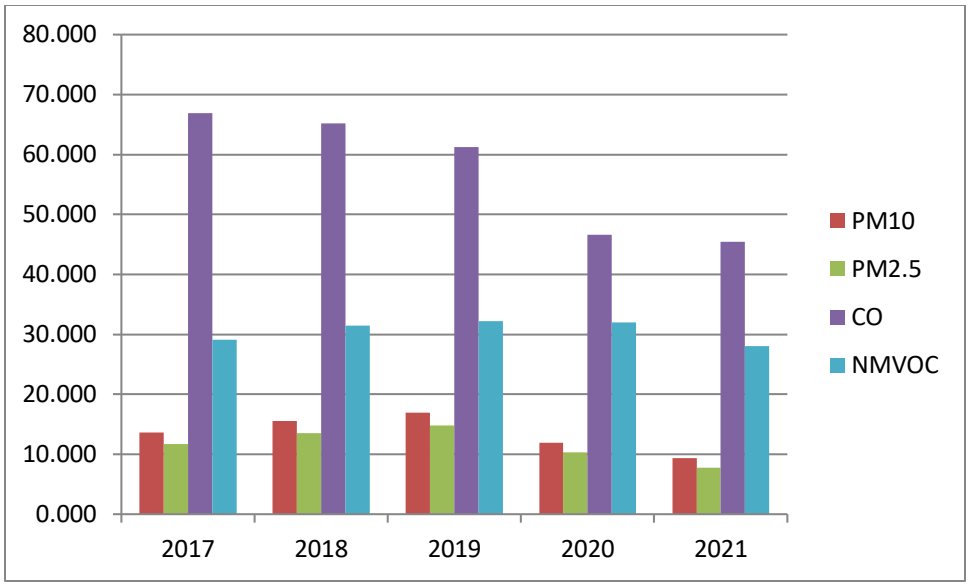

Figure 4Gases (million tons of carbon dioxide equivalents) Causing Air Pollution 2017-2021 Excel data from Transport and environment statistics 2022, 2022

The first chart shows the decrease in emission from 2018 to 2021. The chart shows minimum emission during 2020 that was due to the lockdowns during the COVID period. The emissions are higher for 2021 as compared to 2020, however, lower than 2019. The trend in charts can be interpreted as effectiveness of different policies in UK related to transportation. It can be interpreted that policies are successful towards achieving a greener and clean environment and overcome environment issues. The second chart shows the emission rate of gases that causes Air pollution. Similar case can also be seen in this case, as the gas emissions are decreasing with recent years (Transport and environment statistics 2022, 2022).

The statistic in recent reports shows that gas emissions still needs more robust policies to control down its ratio. Different factors and key trends are highlighted in (National statistics 2023, 2024). According to the report, domestic transport is the highest emitter of greenhouse gases as shown in figure below.

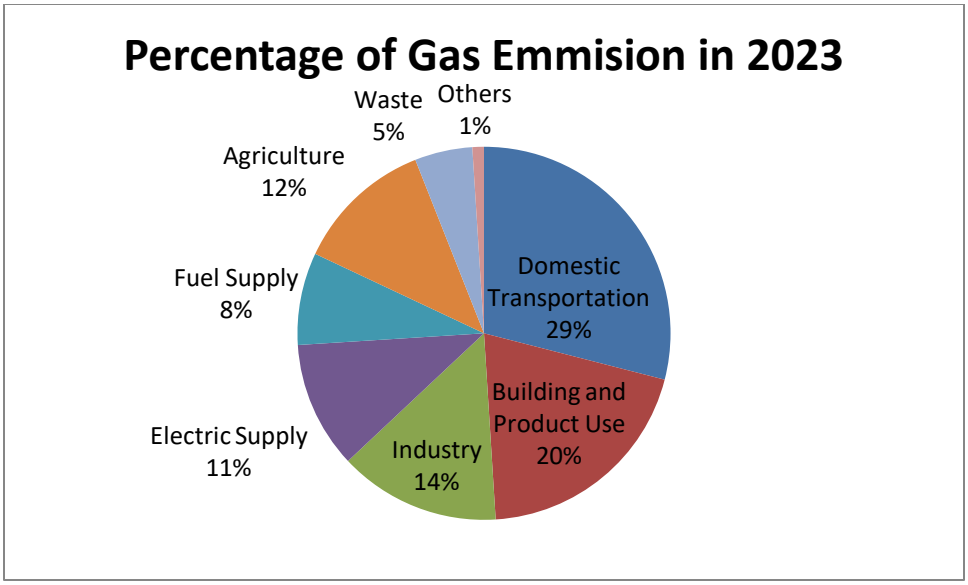

Figure 5 Domestic Transport as Highest Emitter: Source excel data from (National statistics 2023, 2024)

Domestic transportation includes all types of transportation like shipping, road and fishing excluding international aviation. The reports shows increase in green house and other gases emission from 2022 to 2023, but also shows that the increase is still lower than 2019. The primary contributor to emission in these sectors is due to road transport as petrol and diesel is still used in many old vehicles. The report highlights policy intervention and technological advancements as major contributor to the reduction in gas emissions (National statistics 2023, 2024).

The analysis shows that the reduction in emissions can be due to new policies that UK government keeps implementing for securing environment, however, transportation sector is still the highest emitter of gases in the country and the sector needs more consideration and improvement of policies.

4.3 Findings for Analysis of Policies in Reducing the Impact (RQ2)

The analysis of UK policies designed by the government in order to reduce the environmental impacts of the transportation sectors can help in deriving the key points or factors that makes an effective policy. Following is the summarized theoretical assessment of important UK policies:

Clean Air Strategy: The policy of Clean Air strategy was introduced by UK government in the year 2019. Its primary focused was on air pollution problems due to transportation. The objective of the policy is to perform quantitative analysis of air quality data to protect public from hazards of gases emitted due to transportation and other energy usage. The policy covers many other sectors including energy and transportation with main aim to reduce air pollution and promote sustainable practices that protects

environment. Research in (The Lancet Respiratory Medicine, 2019) has evaluated the clean Air strategy of UK. It highlights that there are many negative impacts of air pollution on public health in UK and around the world, this shows that there is significant need to reduce gases emissions that cause air pollution. Same research also highlights that UK has also failed to meet the targets of reducing nitrogen oxide from air, which causes many health problems (The Lancet Respiratory Medicine, 2019). This limitation has been criticized and warned by health professionals in UK. These shows there are gaps in policy implementation and evaluation requiring effective solutions and mitigations. The Clean Air strategy has recommendations and action plans for many local bodies in UK, for implementing the policy however, it lacks clear guidance and funding to complete and meet the targets. This can also be termed as lack of or inappropriate use of resources to overcome the challenges of environmental degradation by the transportation sector. This also shows lack of lack of evaluation and timely refinement of targets (The Lancet Respiratory Medicine, 2019). Codes from C1 to C4 in table 2 are derived from this analysis.

UK decarbonization policy: It consists of electrifying all vehicles to reduce the environmental impacts. Different report and academic papers shows limitation and faults in this policy. According to this policy greenhouse gas emissions will be reduced to overcome the challenges of climate change. The policies consist of two parts related to transportation emissions. The first is to introduce and promote electric vehicles to reduce emission, and the second is to set the target for carbon emissions. Transitioning to renewal energy is also closely linked to this part, as electric vehicles will use batteries being charged in renewal energy. This means use of low carbon technologies will help create a sustainable and environmental friendly UK (Penn et al., 2022)

Environmental and academic researchers have seen many faults in this policy. The main fault identified in the policy is its dependence on use of electric vehicles. EV can reduce carbon emissions, but they are still in early stages to be adopted by the public, moreover, also have environmental impacts in its manufacturing process and also battery disposal (Kalghatgi, 2020;Sheldon, 2022). Fuel efficient vehicles are more environmental friendly as compare to electric vehicles due to use of their heavy batteries and weight management challenge (Kalghatgi, 2020; Sheldon, 2022). Researchers have argued that the policy must include other mechanism which is less dependent on cars and transports means like walking, cycling and promoting use of public transport. The focus of policy is very narrow and researchers have argued to reconsider its points to make the transportation system cleaner in the UK. Academic literature shows incorporating ride sharing and cycling in public transport can minimize environmental effects (Li & Xeng, 2020). The system is considered successful in Netherlands which has

bypassed UK in clean environment. It benefits all stakeholders like taxi drivers, and consumers by reducing their time and fuel consumption. It helps in reducing congestion on roads and also carbon emissions (Li & Xeng, 2020; Penn et al., 2022)

The Climate Change Act: UK implemented Climate Change Act in 2018. Under this act Climate Change Act Committee was established responsible for giving advice to UK government on climate change challenges resolutions covering policies, assessing risks and opportunities, and evaluating the target achieved. It devises recommendations to UK government to improve emissions goals and promote sustainability. It is critical body that keeps track of climate change goals (Poynting, 2024).

As domestic transport is responsible for more than a quarter of gas emissions in the UK, it is the largest emitting sector since years. However, recent report of Climate change Committee published by BBC, shows many short comings of UK in case of transportation policies. Firstly, the government has delayed selling and reselling of petrol cars policy, which it aimed to completely remove from roads till 2035. The electric car sale has increased to 16% in 2022, however low number of charging points is a challenge for electric car usage (Poynting, 2024). The UK electric car usage demands 300,000 publicly available charging points for electric cars from that UK is still far behind. Only 60,000 are installed so far. The CCC has critically analyzed the train and public transport plans of UK and showed dissatisfaction on implementation of plans. To make train transport completely diesel free the plans are not well structured to achieve the goals, moreover, public transport consisting of buses and trams is also seeing very little progress towards low carbon engines (Poynting, 2024).

The Climate Change Committee (CCC) makes a recommendation, arguing that relying simply on technical solutions may not be sufficient to reach targeted emission reduction (CCC, 2023). The committee have emphasized that technological solutions without adequately addressing the behavioral and institutional barriers to their implementation are alone not sufficient to design effective policies. Policy design should incorporate insights from behavioral economics and urban sociology to better understand how individuals and communities respond to policy interventions. Finally, the research also suggests examining policies through the lens of disruption. Through leveraging disruptive technology and behavioral techniques, policymakers can better design and address challenges associated moving towards the sustainable transportation systems that reduces negative impacts of environment (CCC, 2023). This can also be verified from academic research. Research shows that policies effectiveness and successful implementation depends upon public acceptability and their response (Brand et al., 2021). Different publication has emphasized the significance of considering public acceptability and behavioral

factors, such as car purchasing habits and different usage patterns. These techniques help to improve the transition towards more sustainable modes of transport. To motivate adoption of policies by the public and end users of transportation system, it is essential that different dimensions of user behaviors and preferences are included in policy design (Brand et al., 2014, Ekins, 2023). The other factor highlighted in the study is the role of social and lifestyle changes. Lifestyle changes can also help in reducing the impacts. These include minimizing travel patterns and shifting to sustainable transportation options by the public. Therefore, it can be said that it is essential to design policies that not only address technology factors but also encourage changes in individual behavior and social life changes about travel.

The Team Model: Transport Energy Air pollution Model (TEAM) is computer model that is developed with the help of Climate Committee recommendation and UK Energy Research Centre (UKERC)(Brain, 2019). The purpose of the model is to simulate different scenarios related to transportation system use. It consists of latest data on Vehicles owned and used by public, and organizations, how much energy these vehicles use, and how much pollutant they emit. It also provides information on how public and when public travel, and list of all national and international travel vehicles including sea, air and road. The main purpose of the model is to analyze effects of transportation and can therefore, be used by the researchers for evaluating the policy(Brain, 2019).

4.4 Importance of policy Implementation and Comparison with other countries (RQ3)

Theoretical analysis of policies also shows that by 2030, many old vehicles and cars will automatically disappear from roads due to implementation of policies and choice of vehicles from public and organizations. This will lead to reduction in gases that have high effects on human health and environment like NOx and PM2.5 (Mehlig et al., 2021). UK also follows testing requirements of passenger cars that set standards for type of cars passengers can use for travel. Moreover, advancement in technology will further reduce emission and improve environment. The introduction of improved energy efficient cars and electric vehicles will control emissions, having positive impacts on human health and environment (Mehlig et al., 2021).

Overall, the use of energy efficient and electric vehicles will lower gases that causes air pollution and green house effects, research shows gases that are categorized as non exhaust emissions, will remain in

high percentage. This shows that non technological approaches such active transportation and walking is very important in reducing environmental impacts (Mehlig et al., 2021).

UK legislation and policies related to introducing low emission vehicles has been compared in many areas with other successful countries like Netherland. UK has a well defined legislation in this case, however, there are discrepancies in its implementation such selling and reselling of used petrol and diesel cars. This shows UK needs more robust policies and mechanisms to implement the regulations related to improving air quality and reducing green house gases (Quarmby et al., 2019). In UK, Scotland has more extensive and well developed public transport as compare to other parts of UK. That is in Scotland, maximum number of region have easy excess to the public transport that discourages use of private cars contributing to reduction in emissions. However, there is no use of specific public transportation policies that motivates public to use public transport such as free public transport incentives. Such strategies are being implemented in Netherlands and Sweden leaving behind UK in transportation policies and environment target achievements. Scotland has also introduced speed limiting measures similar to other European countries helping in reducing the carbon footprint and minimizing environment degradation, along with the imposing high taxes on petrol and diesel cars as in other parts of UK (Quarmby et al., 2019).

Research by Bardal & Gjertsen, 2020 compares different parts of UK transportation systems. In many part of England and specifically in London, Restrictions on Car Use such as such as tolls, parking fees, and reducing parking opportunities to discourage car is one of non-technological example of policy. However, case study of Denmark and Netherlands shows that it has more developed infrastructure such as pedestrian zones and bike lanes in public transport to make transportation system effective in terms of environment(Liotta, Viguié and Creutzig, 2023). Higher investment in public transport is a strategy in countries like Switzerland and Austria that helps reduce use of public cars and minimize environmental effects. Land use planning and introducing and encouraging ICT tolls for vehicle sharing are also some strategies that can help reduce environmental concerns(Bardal, Gjertsen and Reinar, 2020).

4.5 Themes generation

Thematic coding is used as a research methodology to analyze the content of different selected secondary sources. Thematic software was used for analyzing the text. The task was performed by two researchers independently using different onlinesoftwares to ensure the validity and reliability of the themes and codes extracted. The process followed is inductive as no hypothesis is involved in the

research. A coding framework as illustrated below was followed by both the researchers and documents were coded accordingly.

Two main codes can be derived from Impact of transportation that isGreen house gas emissions and gases that cause air pollution. Summarized in the following table:

Table 1 Code Generation from Impact of transportation

Codes generated from Impact of transportation on environment	
Climate change and greenhouse gases	These gas emissions have negative impact on environment and human health. Carbon dioxide (CO 2) is the most significant greenhouse gas effecting environment and human health
Air Pollution gases	These includes gases carbon dioxide, nitrogen oxides, particulate matter (PM)10 and PM2.5. These emission cause negative impacts on biodiversity and human health

Policies related to reducing these emissions were selected for analysis. Codes were generated while examining different UK policies from government websites and other credible sources. These are identified as second set of code in table 2

Table 2 Codes (Policies Analysis)

Policies	DescriptionCode (From different UK Policies)
Air Strategy (P1) One of the main policy of UK to reduce gas emission harmful for increasing air pollution	Nitrogen Oxide negative impacts on human health, lack of funding despite of clear plans, lack of evaluation, Refinement of targets. Data quality collection needs improvement.

Decarbonization (P2): Decarbonization policy is designed for decreasing emissions of GHG.	Low adoption by public (electric cars), addition of fuel efficient vehicles, Narrow focus, Active Transportation.
Climate Committee (P3)	Petro/diesel car policy, Challenges in implementation of electric cars, large number of buses/tram network still based on diesel, behavioral/public policy integration, TEAM computer based model.
Improvement in Public Transport (P4):	Improving Public Transportation such as reducing number of trains running on diesel. Also Considering active transportation and public behaviors.

Using these impacts as basic codes (table 1), policies of UK were analyzed to derive more codes that are summarized in table 2, labeled from C1-C12. Total 12 codes were generated that will help in deriving themes for further analysis and recommendations. The reports were read in order to trace the weak points in its implementation and other challenges that UK face in making its policies effective.

Table 3 Key Codes from Analysis

Code (Second Set)	Descriptions
Data Quality (C1)	There is a need to Collect better data on air quality that is procedures are inappropriate (Clean air strategy 2019 UK, 2020)
Air pollution impacts on Health(C2)	Impact of air pollution on public health(Clean air strategy 2019 UK, 2020)
Challenges in implementing policies (C3)	Challenges in implementing policies to reduce emissions. Many deficiencies highlighted in Clean Air strategy (Clean air strategy 2019 UK, 2020).
Concerns of Public and organizations (C4)	Research shows public and organizations are not satisfied with the policy implementations in (The Lancet Respiratory Medicine, 2019).
Regulations and Policies (C5)	There is weak implementation of different policies and regulation such as reselling of diesel cars (Quarmby et al., 2019).
Public Transport Strategies (C6)	Introducing free public transport and enhancing public transport

	infrastructure (Quarmby et al., 2019).
Active transportation is equally important (C7)	Non exhaust gases will remain high in ratio despite of electric vehicle and energy efficient solutions.
Car/Ride sharing (C8)	UK must consider policies of country that are performing better than UK in environmental ranking.
Improvement in Decarbonization (C9)	Policy needs improvement in UK as evident from research and CCC reports.
Improved Public transport low carbon automobiles (C10)	UK needs to implement new policy ensuring low carbon public transport transition.
Adding behavior dynamics of public in designing transportation policies (C11)	Policies should include end users preferences like how they will adopt the policy.
TEAM Computer based model (C12)	Can be used for research purpose for evaluating policiesqunatitatively.

These codes were further analyzedand grouped into various categories for deriving more accurate insight into policies effectiveness. The codes made four categories/key strategies of evidence based approach, stakeholder involvement, monitoring and evaluation, and making policy design flexible. These key strategies will help answer research question 2.

Table 4 Codes categorized into Key Strategies RQ2

Code (Second Set)	Key Strategy
Data Quality (C1)	Evidence based Approach
Air pollution impacts on Health(C2)	Monitoring and Evaluation
Challenges in implementing policies (C3)	Flexibility in Policy design
Concerns of Public and organizations (C4)	Stakeholder engagement
Regulations and Policies (C5)	Monitoring and evaluation
Public Transport Strategies (C6)	Stakeholder engagement
Active transportation is equally important (C7)	Stakeholder engagement
Car/Ride sharing (C8)	Stakeholder engagement
Improvement in Decarbonization (C9)	Flexibility and improvement in Policy design
Improved Public transport low carbon automobiles (C10)	Flexibility and Improvement in Policy design
Adding behavior dynamics of public in designing transportation policies (C11)	Stakeholder engagement
TEAM Model	Evidence based Research

Different concepts and themes emerged from the codes as mentioned in table 3 that can be used to make recommendations (RQ3 and RQ4). Following is the set of codes that lead to main policy categories

that should be considered by UK to make improvement. These codes were considered main codes and other codes were linked if they were related.

Table 4 links remaining codes to policy making main categories for themes:

Table 5Main Categories from Codes

Theme	Code	Related Policy (Board categories)	Linked Codes	Reasons
Theme1	P1	Clean Air Policy	C1,C3,C4	UK needs to consider collecting more accurate air quality data for more robust analysis of impact, needs to improve challenges and concerns of public.
Theme2	P2	Decarbonization Policy	C11, C19	Green technology and transportation is part of this policy, however, more aspects of green technology can be added.
Theme3	P3	Climate Committee	C11, 12	Active transportation and behavior dynamics. TEAM computer model for evidence based research.
Theme4	P4	Public Transport Improvement	C5, C8, C10	Improving policy of diesel and patrol car selling and reselling. Adding Active Transportation policy lie other European countries.

4.6 Refining and Interpretation of Themes

The themes identified in the previous analysis suggest that the UK has implemented polices related to decarbonization (Theme2), focusing in the areas of renewable energy deployment and technological innovation. However, problem arises in managing the indirect emissions from use of electric cars/vehicles. Therefore, there is s need of reviewing these policies for effective implementation and risks mitigations. Research also shows that nitrogen oxide ratio will still be higher even after implementing new technologies therefore; Theme 1 and Theme 2 can be combined in to one recommendation for further analysis. Theme 4 suggests sustainable transportation that includes considering technology and public behavior concerns both to evaluate the impacts of policies. Theme 1, theme 3 and themes 4 can be combine to make one recommendation for overall improving policy interventions.

Table 5 Final Themes

Themes	Recommendation
Improving policy effectiveness through Technological Innovation: Theme 1 and Theme2 Decarbonization Policy	How Decarbonization Policy can be improved to make Policies Sustainable through addressing many barriers such as renewable energy integration to use of electric cars (Xu et al., 2021).
Behavioral Change benefits on Policy Design : Theme 3 and Theme 4	Recommendation on how public can be motivated to reduce car travel and adopt active transportation.
Policy Integrations: Combination of Theme 1 (Clean Air Strategy). Theme 3 Active Transportation/behavior dynamics and Theme 4 (Public Transport Improvement)	How both policies can be combined to providemaximum benefits? How each policy can be improved to provide maximum benefits? Make recommendation to UK, how other countries are achieving ambitious targets in this case. (Land use planning and improvement in public transport, promoting cycling within public transport)

4.7 Final Analysis and Result

The research was conducted following a set of research questions elaborated at the beginning of the report. One of the objectives of the research was to make recommendations on how UK can improve its policies in order to minimize environmental Impacts. First research question was related to addressing the environmental sustainability. Using current data from UK statistics, it was found out that UK is reducing GHG and air pollutants, however, transportation sector is the highest emitter in the region which makes it clear that policies and interventions needs to be improved. The analysis only covered single aspect of sustainability that is pollutant reductions and future work can include more aspects of environmental sustainability such as how renewal energy use in transportation can help make environment more clean environment in UK. The second question helped to analyze the policies in terms of positive and negative sides and it was found out that UK needs to combine different policies and improve public transport to minimize environmental affects. Implementing advance solutions requires overcoming many other challenges; therefore, incorporating non technological aspects in policies will help improve environmental hazards. Some key factors of successful policies are involving

stakeholders, performing evidence based research, making policies flexible to adjust new targets, and implementing monitoring and evaluation for polices.

Cases of different countries that are making alternative measures to reach environmental targets were summarized to cover research question 3. Many European countries are investing in active transportation and public transport infrastructure rather than electrification to improve transportation policies. Active transportation included in public transport plays an important part in improving environmental sustainability. UK is in initial stage of active transportation. Future qualitative research on active transportation can help derive more accurate results to cover the research objective. Different recommendations were proposed for enhancing the sustainability of transportation systems in the UK based on the findings of the analysis that helped to answer the research question 4.

Therefore considering the aforementioned findings from this current research the gap identified in the literature review have been substantially filled. The research can provide a base for conducting detail survey on evaluation of UK policies that are directed towards reducing emissions and improving environment. To overcome the gap in statistical analysis of policies the research recommends using TEAM model designed by UK government that can provide comprehensive and specific data on UK transportation sectors and emissions from these sectors. By covering the statistical analysis of emission and identifying key strategies for improving UK polices research objectives and questions were partially fulfilled. Key factors needs more detail description and analysis through further qualitative analysis. The addition of quantitative data analysis from real statistics can add more validity and reliability to the findings.

4.8 Conclusion

The chapter provided detailed analysis of UK policies related to transportation. It covered the research questions that were designed to guide the research. The first research question aimed to find how UK I addressing the environmental sustainability. Statistical data showed that transport sector is the highest emitter and more comprehensive policies are required to handle the situation. Different polices were assessed in term of positive and negative points to find out the areas for improvement and successful implementation. Thematic analysis was applied to derive different codes and themes while analyzing the content of research articles, industry and government reports. Key strategies, Issues, and other important entities as codes were framed into themes to devise recommendation for UK to improve their polices in overcoming the environment harm caused by the transportation system.

5. Recommendations and Conclusion

5.1 Conclusion

The results and findings from previous section can be mapped to the specified objectives and research questions in the study. The research aimed to covered GHS gas emissions and air pollution gases that are causing damage to environment. The transportation sector is the highest emitter of the gases in the UK, and therefore, its policies need further consideration to meet the challenge. The research successfully analyzed important UK policies that were introduced as a result of Paris agreement for overcoming the climate change challenges. These policies are decarbonization, and Clean Air strategy. The weak points and challenges in the policy derive key factors that should be included in the policies to make them more robust. These are the stakeholder engagement, monitoring and evaluation to meet different criteria's, flexibility in policy design and evidence based research for accurately determining the set targets of emissions. As compare to other European countries, UK needs more robust active transportation that overcomes challenges of implementing technology based policies that are costly and time consuming processes. UK government must analyze and evaluate it policies using TEAM computer model to provide insights into success of policies it has so far implemented.

5.2 Recommendations

To improve its policies UK must consider improving public transportation. Public transportation must be improved to adjust active transportation planning, Land use planning that is creating minimum distances between commercial and work areas, and vehicle sharing both private and public using ICT technologies, and involving stakeholders that is public behaviors and preferences in policy design. Public awareness though educational programs and outreach programs can help in increasing ware ness of active transportation. More local extensive research is lso required to know the behavior dynamics of public in case of adoption of active transportation. These recommendations are less dependent on use of technology such as electrification that comes with more environmental challenges to deal with (Liotta, Viguié and Creutzig, 2023).

However, investing and innovating in technology is still required. UK must keep it current success in introducing new technologies making electric vehicles in line with conventional vehicles in terms of price, speed and performance. Different implication in this case are public awareness and education about environmental effects of carbon emissions and advantages of EV, collaboration between different stakeholders to increase it adoption by public, making charging more accessible to public, and

introducing electric vehicles in rural and low income community areas in some form to boost its adoption (Xu et al, 2021).

5.3 Limitation of Study

Scope of the study was limited to freely available UK government reports on transportation sector. Also no primary collection was utilized such as interview and questionnaires from transportation department to include more knowledge and data for better analysis. Also the policies included for analysis were limited to GHS and air pollution gas emission such as Clean Air and decarbonization. More policies analysis could have added more detailed assessment. In terms of sustainability, technological and social aspect of policy were included, however, economic challenges and barriers were excluded from the analysis. The conclusion of the research form the key strategies for improvement that can serve as some of the factors for in depth analysis and evaluation for future research based on both types that is statistical models and theoretical frameworks.

5.4 Contribution to Current Literature Gap and future work

Two main literature gaps were identified in the research. Overall limited recent research after 2020 was found related to UK transportation policy evaluations. There was also a lack of comprehensive qualitative research specific to UK policies only to determine their effectiveness. The statistical research suffered from limited data access to provide more accurate results. The current research derived some key strategies and metric that can be used to form the basis of both qualitative and quantitative future research. These key metric are stakeholder engagement, policy flexibility, and monitoring and evaluation. The recommendation section can help policy makers consider some areas to reach environment targets on time. The research form basis for future systematic review of UK transportation policy, and also highlights role of accurate and diverse data in making more robust evaluation of policies. The overcome this research gap, TEAM model can help future researchers explore more dimensions of the model and make it part of their statistical and quantitative research.

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