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SUSTAINABILITY AND CARBON FOOTPRINT REDUCTION IN THE UK TRANSPORTATION INDUSTRY – CHALLENGES AND STRATEGIC RESPONSES BY BUSINESSES.

By

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Master of Research

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ABSTRACT

The UK transportation industry faces growing pressure to reduce carbon emissions while maintaining operational efficiency and long-term competitiveness. This study examines how transportation businesses respond to sustainability and carbon reduction pressures, focusing on the strategies they adopt, the challenges they encounter and the organisational responses that influence implementation.

A qualitative Systematic Literature Review (SLR) was conducted using predefined search and selection criteria. Sixteen relevant studies were included in the final review and analysed using thematic analysis. Four main themes emerged: sustainability in transportation, carbon reduction strategies, challenges faced by businesses and strategic responses by businesses.

The findings show that sustainability has become more than an environmental concern; it is increasingly a strategic business priority. Transportation businesses are adopting measures such as low-carbon technologies, operational improvements, sustainability governance and stakeholder collaboration. However, implementation is affected by interconnected financial, technological, operational, organisational and regulatory challenges. The evidence also suggests that businesses are better positioned to achieve sustainability objectives when carbon reduction initiatives are supported by strong organisational capabilities, collaboration and adaptive management.

The study concludes that transportation decarbonisation is not simply a technological challenge. Meaningful carbon reduction requires businesses to integrate technology with effective governance, organisational capability and stakeholder engagement. By bringing these factors together, the research provides a business-focused understanding of how transportation organisation's can navigate sustainability challenges and support longer-term decarbonisation.

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CHAPTER 1: INTRODUCTION

The transition towards a low-carbon economy has become a central priority for governments, businesses, and society as efforts to address climate change intensify. Among the sectors expected to play a significant role in this transition, transportation remains one of the most challenging. While transportation is fundamental to economic growth, trade, mobility, and supply chain operations, it is also a major contributor to greenhouse gas (GHG) emissions. In the United Kingdom, transport has remained one of the largest emitting sectors despite sustained policy efforts aimed at reducing national carbon emissions and achieving the government's net-zero target by 2050 (Department for Transport, 2021). Consequently, improving sustainability within the transportation industry has become an important environmental, economic, and strategic priority.

Existing research has identified numerous pathways for reducing transportation-related emissions, including the adoption of electric vehicles, alternative fuels, route optimisation technologies, multimodal transport systems, digital transport solutions, and low-carbon infrastructure development (Teoh et al., 2018; Oliveri et al., 2023; Li et al., 2022). These studies have made significant contributions towards understanding the environmental benefits and technical feasibility of carbon reduction initiatives. However, the transportation industry's transition towards sustainability involves more than technological change alone. Decarbonisation requires businesses to make complex operational, financial, and strategic decisions while continuing to meet customer expectations, maintain profitability, and remain competitive within rapidly changing market conditions.

Despite increasing attention to transportation sustainability, a key challenge remains insufficiently understood. Transportation businesses are under growing pressure to reduce carbon emissions and align their operations with sustainability objectives, yet the implementation of sustainability strategies continues to be constrained by financial limitations, technological uncertainty, infrastructure gaps, regulatory complexity, and operational risks (Neagoe et al., 2024; Karam et al., 2023; Kervall and Pålsson, 2023). Although existing literature has extensively examined transport emissions, environmental impacts, and technological solutions, there is comparatively limited understanding of how businesses themselves respond strategically to these pressures and navigate the challenges associated with carbon reduction. As a result, current knowledge provides only a partial understanding of the practical realities surrounding sustainability implementation within the transportation sector.

This gap is particularly important because businesses occupy a central position within the decarbonisation process. Governments may establish environmental targets and policy frameworks, while researchers may identify technological solutions and sustainability pathways. However, it is businesses that ultimately make investment decisions, operational adjustments, technology adoption choices, and strategic commitments required to achieve carbon reduction outcomes. Consequently, the success of transportation decarbonisation depends not only on the availability of sustainable technologies or supportive policies but also on how transportation businesses interpret, adopt, implement, and manage sustainability initiatives within their operational environments (Damert and Baumgartner, 2018; Kim, 2022; Lozano, 2023).

Furthermore, existing studies frequently examine sustainability from either a technological, environmental, or policy perspective, often treating businesses as passive recipients of sustainability requirements rather than active strategic actors. This has resulted in limited integration between transportation sustainability research and business strategy literature. Consequently, there remains insufficient understanding of how transportation organisations balance competing priorities such as environmental responsibility, operational efficiency, financial performance, regulatory compliance, and long-term business resilience. Understanding these business-level responses is critical because the effectiveness of sustainability policies and carbon reduction strategies ultimately depends on their successful implementation by organisations operating within the transportation sector.

The UK transportation industry provides an important context for investigating these issues. The sector faces increasing pressure to contribute towards national decarbonisation targets while simultaneously maintaining service reliability, supporting economic activity, and responding to evolving customer and stakeholder expectations. These competing demands create significant strategic and operational challenges for businesses seeking to reduce their carbon footprint. Therefore, examining the challenges faced by businesses and the strategies they adopt in response provides an opportunity to generate a more comprehensive understanding of transportation sustainability beyond purely environmental or technological perspectives.

Against this backdrop, this study examines sustainability and carbon footprint reduction within the UK transportation industry, with particular focus on the challenges faced by businesses and the strategic responses adopted to address them. By exploring sustainability from a business-centred perspective, the study seeks to contribute to a deeper understanding of how organisations respond to carbon reduction

pressures and the factors influencing the successful implementation of sustainability initiatives within the transportation sector.

1.1 Research Background

The transportation industry is fundamental to economic growth, trade, supply chain operations, and societal mobility. However, its continued dependence on fossil fuels has made it a significant contributor to greenhouse gas (GHG) emissions, air pollution, and climate change (Brand et al., 2012; Zhang, 2024). As global concerns about climate change have intensified, governments and businesses have faced increasing pressure to pursue more sustainable transportation systems capable of supporting economic activity while reducing environmental impacts.

Within the United Kingdom, transportation occupies a central position in sustainability discussions due to its contribution to national emissions and its importance to economic development. The UK's commitment to achieving net-zero greenhouse gas emissions by 2050 has increased expectations for transportation businesses to reduce their carbon footprint and demonstrate measurable progress towards sustainability objectives (Department for Transport, 2021). Consequently, sustainability has evolved from environmental concern into a strategic business issue that influences investment decisions, operational planning, and long-term competitiveness.

Despite growing commitment to transportation decarbonisation, achieving sustainability remains challenging. Transportation businesses must balance environmental objectives with operational efficiency, service reliability, customer expectations, profitability, and regulatory compliance. Furthermore, sustainability initiatives such as fleet electrification, alternative fuels, digital technologies, and low-carbon logistics systems often require substantial investment and organisational change while delivering benefits over longer time horizons (Neagoe et al., 2024; Xuqian, 2024). These competing demands mean that sustainability implementation frequently involves difficult strategic trade-offs.

The complexity of transportation sustainability is reinforced by the interconnected nature of transportation systems. Emissions are influenced not only by vehicle technologies but also by infrastructure, energy systems, logistics operations, regulatory frameworks, and stakeholder behaviour (Brand et al., 2012; Jelti et al., 2023). Consequently, transportation sustainability is increasingly viewed as a systemic challenge requiring coordinated action across governments, transportation operators, suppliers, customers, and infrastructure providers rather than a problem that can be solved through technology alone (Gasparatos et al., 2009; Zhang, 2024).

Although transportation businesses have adopted a range of sustainability initiatives, including green logistics, carbon management, operational efficiency measures and low-carbon vehicle technologies, evidence indicates that their effectiveness varies according to the conditions within which they are implemented (Herold and Lee, 2017; Oliveri et al., 2023). At the same time, organisations continue to face barriers such as financial constraints, technological uncertainty, infrastructure limitations, regulatory complexity, and stakeholder conflicts (Karam et al., 2023; Kervall and Pålsson, 2023; Neagoe et al., 2024). This suggests that the challenge is no longer simply identifying sustainability solutions but understanding how businesses implement and manage them within real operating environments.

Existing research has generated substantial knowledge regarding transportation emissions, environmental impacts, and carbon reduction technologies. However, comparatively less attention has been given to understanding how transportation businesses themselves respond strategically to sustainability pressures and navigate implementation challenges. Given that businesses ultimately make the investment, operational, and strategic decisions that determine whether sustainability initiatives succeed, examining their responses is critical to understanding the practical realities of transportation decarbonisation. Against this backdrop, this study investigates sustainability and carbon footprint reduction within the UK transportation industry by focusing on the challenges faced by businesses and the strategic responses adopted to address them.

1.2 Research Problem

The transportation sector has become a major focus of sustainability research due to its significant contribution to greenhouse gas emissions and its importance to economic activity. In response, governments, policymakers, and industry stakeholders have promoted a range of carbon reduction initiatives, including electric vehicles, alternative fuels, green logistics and carbon management practices (Herold and Lee, 2017; Teoh et al., 2018; Oliveri et al., 2023). While these developments have improved understanding of transportation decarbonisation and generated numerous sustainability solutions, achieving meaningful and sustained carbon reductions remains a significant challenge.

Evidence suggests that transportation businesses continue to face financial constraints, technological uncertainty, infrastructure limitations, regulatory complexity, and operational pressures when attempting to implement sustainability initiatives (Jelti et al., 2023; Karam et al., 2023; Neagoe et al., 2024). Consequently, the availability of carbon reduction technologies and supportive policies does not automatically translate into successful implementation or improved environmental performance. This

highlights an important distinction between identifying sustainability solutions and successfully embedding them within organisational practice.

A further limitation within existing literature is its tendency to examine transportation sustainability primarily from technological, environmental, or policy perspectives. Although these studies have generated valuable insights into emissions reduction pathways and environmental performance (Brand et al., 2012; Zhang, 2024), comparatively less attention has been given to understanding how businesses respond strategically to sustainability pressures and manage implementation challenges. As a result, transportation sustainability is often presented as a technical problem rather than an organisational and strategic challenge.

This gap is significant because businesses occupy a central role in the decarbonisation process. While governments establish environmental targets and researchers propose sustainability solutions, businesses ultimately make investment, operational, and strategic decisions that determine whether carbon reduction initiatives are successfully implemented. However, organisations must balance environmental objectives with financial performance, operational efficiency, customer expectations, and long-term competitiveness (Damert and Baumgartner, 2018; Kim, 2022; Lozano, 2023). Understanding how businesses manage these competing priorities therefore remains critical to evaluating the practical feasibility of transportation sustainability.

The problem is particularly relevant within the UK transportation industry, where organisations face increasing pressure to contribute towards national net-zero objectives while maintaining operational and commercial viability. Despite growing attention to transportation decarbonisation, there remains limited integrated understanding of how transportation businesses navigate sustainability challenges and the strategic responses they adopt to support carbon footprint reduction. Therefore, the central research problem addressed by this study is the limited understanding of how transportation businesses operating within the UK context respond to sustainability pressures while managing the challenges associated with carbon reduction. Addressing this problem is important because the success of transportation decarbonisation ultimately depends not only on technological innovation and policy ambition, but also on the ability of businesses to translate sustainability objectives into effective organisational practice.

1.3 Aim and Objectives

Aims

The aim of this study is to examine sustainability and carbon footprint reduction within the UK transportation industry by exploring the challenges faced by businesses and the strategic responses adopted to address them.

Objectives

1. To examine sustainability issues relating to carbon emissions within the UK transportation industry.
2. To identify the main challenges transportation businesses face in reducing their carbon footprint.
3. To explore the sustainability strategies adopted by businesses within the transportation sector.
4. To critically examine the effectiveness of sustainability strategies adopted by transportation businesses in reducing carbon emissions and supporting environmental sustainability goals.

1.4 Research Questions

Main Research Question

What challenges do businesses face in reducing carbon footprints within the UK transportation industry, and how do they respond strategically to these challenges?

Supporting Questions

1. What sustainability strategies are being adopted by transportation businesses in the UK?
2. What barriers affect the implementation of carbon reduction initiatives in the transportation sector?
3. How effective are current sustainability strategies in reducing carbon emissions?

1.5 Significance of Study

This study makes an important academic contribution to the growing body of literature on sustainability, transportation decarbonisation, and business strategy. Existing research has generated extensive knowledge regarding transportation emissions, environmental impacts, carbon reduction technologies, and sustainability policy frameworks (Brand et al., 2012; Zhang, 2024; Jelti et al., 2023). However, much of this literature remains fragmented, often examining technological solutions, environmental outcomes, or policy interventions independently. Comparatively less attention has been given to understanding how transportation businesses strategically respond to

sustainability pressures and implement carbon reduction initiatives within complex operational environments.

The study contributes to knowledge by bringing together three interconnected areas of research that are frequently examined separately: transportation sustainability, carbon footprint reduction, and business strategic responses. By integrating these perspectives, the research provides a more holistic understanding of sustainability implementation within the transportation sector. In doing so, it responds to calls within the literature for greater examination of the organisational and strategic dimensions of sustainability transitions rather than focusing predominantly on technological or policy solutions (Lozano, 2023; Kim, 2022).

A second academic contribution lies in its focus on implementation rather than technological potential. Existing studies have extensively explored the environmental benefits of electric vehicles, alternative fuels, multimodal transport systems, and low-carbon technologies (Teoh et al., 2018; Oliveri et al., 2023; Li et al., 2022). However, there remains limited understanding of how businesses navigate the practical challenges associated with implementing these sustainability initiatives. By examining both the barriers faced by businesses and the strategic responses adopted to overcome them, the study extends current understanding of the relationship between sustainability ambitions and implementation realities within the transportation sector.

Thirdly, the study contributes to the limited body of research focusing specifically on transportation businesses operating within the UK context. While many sustainability studies adopt global perspectives or concentrate on policy development and technological innovation, relatively few studies examine how UK transportation businesses respond strategically to sustainability pressures. Given the UK's ambitious decarbonisation agenda and the significant role of transportation in national emissions, a business-focused perspective offers valuable insight into how sustainability objectives are translated into organisational action.

Beyond its academic contribution, the study also has practical relevance. The findings may assist transportation businesses, sustainability managers, policymakers, and industry stakeholders in understanding the challenges that influence carbon reduction efforts and the strategies that can support more effective sustainability implementation. Insights from the study may contribute to the development of more realistic and

achievable approaches to transportation decarbonisation by recognising the operational, financial, technological, and organisational realities faced by businesses.

Ultimately, the significance of this study lies in its contribution towards a more integrated understanding of transportation sustainability. Rather than viewing carbon reduction solely as a technological or policy challenge, the study recognises it as a strategic business challenge that requires organisational adaptation, resource commitment, and long-term decision-making. By focusing on the experiences and responses of businesses, the research provides a perspective that is essential for understanding how sustainability objectives can be translated into meaningful and lasting reductions in carbon emissions within the transportation industry.

CHAPTER 2: BACKGROUND AND LITERATURE REVIEW

2.1 Sustainability in Transportation

Transportation sustainability has become an increasingly important component of global and national climate agendas because of the sector's contribution to greenhouse gas emissions and its dependence on carbon-intensive energy systems. Earlier research largely approached sustainable transportation through emissions reduction, energy efficiency and the environmental consequences of transport activity (Brand et al., 2012). However, the concept has progressively broadened to recognise that sustainable transportation must balance environmental objectives with economic performance, social considerations and the continued provision of reliable mobility and logistics services (Herold and Lee, 2017; Lozano, 2023). This broader perspective is particularly relevant to businesses because sustainability initiatives must operate within commercial and operational constraints rather than being assessed solely in terms of environmental benefits.

This evolution has resulted in differing perspectives regarding how transportation sustainability should be achieved. Technology-oriented studies emphasise interventions such as vehicle electrification, alternative fuels, digitalisation and improvements in energy efficiency (Li et al., 2022; Oliveri et al., 2023). Such approaches provide important opportunities for reducing emissions, but their effectiveness depends on supporting infrastructure, energy systems and implementation conditions. In contrast, broader systems-oriented research argues that technological improvements alone are unlikely to deliver the required transition without corresponding changes in policy, organisational practices and stakeholder behaviour (Brand et al., 2012; Lozano, 2023).

The literature therefore suggests that transportation sustainability should be understood not simply as a technological transition, but as a multidimensional process involving interactions between environmental, economic, organisational and institutional factors.

Recent literature reinforces this broader interpretation while also demonstrating that the different dimensions of sustainability remain unevenly developed. Blokus-Dziula and Dziula (2026), reviewing recent transport decarbonisation research, identify substantial attention to technologies, infrastructure, policy, management systems and costs, but find that human and social dimensions remain comparatively underrepresented. This extends earlier systems-oriented arguments by showing that, despite the increasing sophistication of transportation sustainability research, technological and efficiency considerations continue to receive greater attention than some of the organisational and human factors affecting transition.

The literature also highlights tensions between environmental ambition and business feasibility. Transportation organisations must reduce emissions while maintaining service reliability, operational efficiency and financial viability. This creates potential trade-offs where low-carbon technologies require significant capital investment, supporting infrastructure or changes to established operating models. Consequently, the environmental potential of a sustainability initiative does not necessarily guarantee its organisational feasibility. This distinction is important because it shifts the discussion from identifying available carbon-reduction solutions towards understanding the conditions under which businesses can implement them successfully.

Overall, the literature demonstrates a gradual transition from relatively narrow emissions-focused interpretations of sustainable transportation towards a more integrated understanding incorporating technology, infrastructure, economics, policy and organisational considerations. Nevertheless, the continued prominence of technological and system-efficiency perspectives suggests that greater attention is required to the business and organisational processes through which sustainability ambitions are translated into practice. This provides the basis for examining the specific carbon reduction strategies available to transportation businesses in the following section.

2.2 Carbon Reduction Strategies

The growing recognition of transportation as a major contributor to greenhouse gas emissions has stimulated extensive research into strategies for reducing the sector's carbon footprint. These strategies address emissions associated with vehicle operations, freight movement, passenger transport, energy consumption and logistics activities. Although the literature broadly agrees on the need for transportation decarbonisation, there is less consensus regarding which interventions can deliver effective and sustainable outcomes. Existing research therefore presents a combination of technological, operational, organisational and collaborative approaches rather than a single pathway to decarbonisation.

Technological innovation remains one of the most prominent strategies. Electric vehicles (EVs), hydrogen-powered systems, biomethane and alternative fuels are frequently presented as mechanisms for reducing dependence on conventional fossil fuels (Teoh et al., 2018; Li et al., 2022; Oliveri et al., 2023). However, evidence increasingly challenges the assumption that technological substitution alone guarantees sustainability. Oliveri et al. (2023) demonstrate that the environmental performance of EVs depends partly on electricity generation, battery production and end-of-life management, while Teoh et al. (2018) identify charging infrastructure and operational requirements as additional constraints. More recent UK evidence reinforces these trade-offs. Bamigbe et al. (2026), examining food freight in Lincolnshire, find battery-electric vehicles comparatively suitable for short-haul and last-mile operations, while hydrogen and electric-road systems may offer advantages for heavier or longer-distance applications but involve greater infrastructure investment, energy losses and system costs. The evidence therefore suggests that technology selection must reflect operational context rather than assuming that one low-carbon technology is universally applicable.

Operational efficiency provides another route to carbon reduction. Route optimisation, improved fleet utilisation, eco-driving, load optimisation and intelligent transport systems can reduce fuel consumption and emissions without necessarily requiring immediate replacement of existing assets (Herold and Lee, 2017; Li et al., 2022). These measures can therefore offer businesses both environmental and economic benefits. Their limitation, however, is one of scale. Efficiency improvements may produce incremental reductions rather than the structural change required for deep decarbonisation, while increasing transport demand can offset some gains through rebound effects (Herold and Lee, 2017; Li et al., 2022). Operational efficiency should therefore be regarded as complementary to, rather than a substitute for, longer-term transition strategies.

Green logistics broadens the focus beyond individual vehicles by integrating environmental considerations into transport planning, distribution, freight operations and supply-chain management. Strategies include improved resource utilisation, modal shifts, sustainable transport planning and greater supply-chain coordination (Herold and Lee, 2017; Bilek et al., 2024). This system's perspective is significant because the environmental performance of transport businesses is often influenced by actors beyond their direct organisational boundaries. Bilek et al. (2024) consequently emphasise collaboration between shippers, logistics providers, suppliers and customers through information sharing and coordinated sustainability initiatives. Carbon reduction therefore becomes partly an inter-organisational challenge rather than solely the responsibility of individual firms.

Carbon management represents a further organisational strategy. Herold and Lee (2017) argue that emissions reduction requires systematic measurement, monitoring, reporting and management alongside technological intervention. Such systems allow businesses to identify emission sources, establish targets and assess progress. Recent evidence strengthens this argument. Steger-Jensen et al. (2025) highlight continuing difficulties for logistics operators in calculating and documenting actual transport emissions, particularly within last-mile operations. This creates an important distinction between implementing a carbon reduction initiative and demonstrating that it has produced measurable environmental improvement. Effective carbon management therefore provides a mechanism through which sustainability objectives can be incorporated into organisational decision-making and evaluated over time.

Modal shift is also widely discussed as a system-level strategy. Greater use of public transport, rail, active mobility and multimodal freight can reduce dependence on more carbon-intensive modes (Teoh et al., 2018; Li et al., 2022). However, modal substitution depends on infrastructure availability, accessibility, service quality and behavioural acceptance. Its effectiveness therefore extends beyond the control of individual businesses and frequently requires sustained public investment, policy support and coordination between transport actors.

These competing approaches reflect a broader debate over whether transportation decarbonisation should be primarily technology-led or systems-led. Technology-focused perspectives emphasise electrification, alternative fuels and vehicle innovation (Oliveri et al., 2023; Li et al., 2022), whereas systems-oriented research stresses the combined importance of operational improvement, behavioural adaptation, policy intervention and organisational transformation (Herold and Lee, 2017; Bilek et al., 2024). The evidence does not necessarily make these perspectives mutually exclusive. Rather, it indicates that their effectiveness is interdependent: technological solutions

require appropriate infrastructure and organisational capabilities, while operational and collaborative strategies may be insufficient to achieve deep emissions reductions without technological change.

Overall, transportation businesses have access to a diverse range of carbon reduction strategies, but their effectiveness depends on technological maturity, infrastructure, organisational capability, financial feasibility, regulatory conditions and stakeholder coordination. Consequently, transportation decarbonisation is better understood as a **portfolio of complementary interventions** than as reliance on a single technological or operational solution. The availability of these strategies, however, does not guarantee successful implementation. Businesses must determine which interventions are technically appropriate, commercially viable and operationally sustainable within their specific circumstances, creating the implementation challenges examined in the following section.

2.3 Challenges Faced by Businesses

Despite the growing availability of carbon reduction strategies and increasing pressure to improve environmental performance, transportation businesses continue to face substantial challenges in implementing sustainability initiatives. The literature increasingly demonstrates that transportation decarbonisation is more complex than the adoption of cleaner technologies or compliance with environmental policies alone (Jelti et al., 2023; Neagoe et al., 2024). Businesses operate within interconnected financial, technological, infrastructural, regulatory, organisational and operational constraints, meaning that the feasibility of a sustainability initiative often depends on several conditions being satisfied simultaneously. Transportation sustainability therefore represents not only an environmental or technological challenge, but also a strategic business problem involving investment decisions, organisational capability and commercial risk.

Financial constraints are among the most consistently identified barriers. Decarbonisation may require substantial expenditure on low-carbon vehicles, charging or alternative-fuel systems, digital technologies, employee training and operational restructuring (Neagoe et al., 2024; Xuqian, 2024). Although these investments may generate longer-term environmental and economic benefits, businesses must often commit capital before technological performance, infrastructure availability or future regulatory conditions are fully known. Xuqian (2024) identifies financing constraints as an important limitation on green innovation, while Neagoe et al. (2024) similarly highlight the high capital costs associated with alternative-fuel technologies. More recent evidence reinforces this relationship between investment and uncertainty. Alam

et al. (2025) identify profitable return on investment, subsidies and financial support as major drivers of decarbonisation, suggesting that financial viability can function either as a barrier or an enabler depending on the economic conditions surrounding adoption. This indicates that willingness to decarbonise does not necessarily translate into investment where the commercial case remains uncertain.

Financial risk is closely connected to **technological uncertainty**. Electric vehicles, hydrogen, biomethane and other low-carbon technologies offer considerable emissions-reduction potential, but concerns remain around vehicle range, charging or refueling time, payload implications, technology maturity and energy availability (Jelti et al., 2023; Neagoe et al., 2024). These limitations are particularly significant for commercial transportation because operational reliability is fundamental to service delivery. Recent UK evidence illustrates this trade-off clearly. Bamigbe et al. (2026) find that different freight technologies involve distinct combinations of capital cost, infrastructure requirements, operational suitability and emissions performance, meaning that technologies suitable for short-distance operations may not offer equivalent feasibility for heavier or long-haul applications. This challenges the assumption that businesses face a straightforward choice between conventional and low-carbon technologies; rather, they must make strategic decisions under conditions of technological and commercial uncertainty.

Infrastructure limitations further complicate these decisions. Low-carbon transportation technologies depend on supporting systems including charging networks, alternative-fuel infrastructure, electricity generation and distribution capacity, digital systems and multimodal facilities (Jelti et al., 2023; Karam et al., 2023). However, infrastructure development does not always progress at the same rate as technological innovation. Karam et al. (2023), for example, identify inadequate infrastructure as a major obstacle to multimodal transport adoption. Alam et al. (2025) similarly identify technical and infrastructure barriers among the most significant constraints affecting road transport decarbonisation. This creates a structural dependency for businesses: organisations may possess both the intention and financial capacity to invest in low-carbon technologies but remain constrained by infrastructure that lies largely outside their direct control. The effectiveness of firm-level sustainability strategies is therefore partly dependent on wider energy, transport and public infrastructure systems.

Regulatory and policy conditions create a related challenge. Governments use emissions targets, environmental standards, taxation, incentives and other policy instruments to accelerate transport decarbonisation. Such measures can stimulate investment, but uncertainty regarding future standards, incentives or transition timelines may also increase business risk (Neagoe et al., 2024; Kervall and Pålsson,

2023). This creates an important tension: businesses require policy pressure to accelerate transition but also require sufficient regulatory stability to justify long-term capital commitments. Recent UK road-freight research demonstrates the significance of this problem. Churchman et al. (2026) show that operators may face competitive risks where firms investing early in more expensive low-carbon technologies compete against businesses continuing to operate cheaper conventional vehicles. Decarbonisation therefore raises questions not only about regulatory compliance but also about how transition costs and competitive risks are distributed across an industry.

Organisational capability represents another important but sometimes less visible barrier. Sustainability transitions may require new technical knowledge, management practices, employee competencies, performance measures and changes in organisational culture (Jelti et al., 2023; Xuqian, 2024). Resistance may arise where sustainability objectives are perceived as conflicting with existing operational priorities, particularly when their benefits are long-term while implementation costs are immediate. The challenge therefore extends beyond acquiring new technology to developing the organisational capacity to use, manage and integrate it effectively. This distinction is important because similar technologies may produce different outcomes across businesses depending on leadership commitment, internal expertise, resources and capacity for organisational change.

Stakeholder complexity further limits the extent to which businesses can manage decarbonisation independently. Transportation systems involve operators, governments, infrastructure providers, manufacturers, suppliers, customers and communities whose priorities may not always align (Kervall and Pålsson, 2023). For example, businesses may prioritise affordability and operational reliability while policymakers emphasise emissions targets and customers simultaneously expect low prices, rapid delivery and improved environmental performance. Kervall and Pålsson (2023) identify such stakeholder conflicts as a significant obstacle to sustainable urban freight development. Churchman et al. (2026) extend this argument in the UK road-freight context by showing that transition requires coordination among multiple actors rather than isolated decisions by individual operators. Sustainability implementation is therefore partly a governance and coordination problem in which organisational outcomes depend on decisions made across the wider transport ecosystem.

These pressures ultimately converge at the **operational level**. Transportation businesses must continue meeting requirements for cost, reliability, flexibility, safety and service quality while reducing emissions. Sustainability interventions may alter routes, refueling or charging arrangements, fleet availability, payload capacity and existing working practices, potentially creating tension between immediate operational

performance and longer-term environmental objectives (Neagoe et al., 2024; Karam et al., 2023). This tension is particularly significant because environmental strategies that cannot maintain acceptable operational performance are unlikely to remain commercially sustainable. The challenge for businesses is therefore not simply achieving lower emissions but doing so without undermining the operational viability on which the organisation depends.

Critically, these barriers should not be interpreted as independent problems. Jelti et al. (2023) demonstrate that financial, technological, organisational, social and regulatory barriers interact, while the more recent evidence reinforces this interdependence. High technology costs become more problematic where infrastructure is inadequate; infrastructure uncertainty increases investment risk; regulatory uncertainty can delay capital commitment; and limited organisational capability may prevent businesses from exploiting technologies that are otherwise technically viable. Conversely, financial incentives and stable policy can reduce investment risk and accelerate adoption (Alam et al., 2025). This suggests that the success or failure of transport decarbonisation is shaped less by any single barrier than by the combined configuration of constraints and enabling conditions confronting businesses.

Overall, the literature demonstrates that transportation businesses operate within a complex transition environment where environmental ambitions must be reconciled with financial capacity, technological maturity, infrastructure availability, regulatory certainty, organisational capability, stakeholder expectations and operational requirements. Recent studies strengthen rather than overturn earlier evidence concerning these barriers, but they also demonstrate more clearly how the challenges interact and vary according to technology, geography and transport subsector. Consequently, identifying individual barriers is insufficient to explain sustainability implementation. Greater attention must also be given to how businesses interpret these constraints, prioritise competing requirements and develop strategic responses capable of maintaining commercial viability while progressing towards carbon reduction objectives. These organisational responses are considered in the following section.

2.4 Strategic Responses by Businesses

The challenges associated with transportation sustainability have prompted businesses to adopt a range of strategic responses aimed at reducing carbon emissions while maintaining operational efficiency and commercial competitiveness. As sustainability pressures have intensified, organisations have increasingly moved beyond purely compliance-based approaches towards strategies that integrate environmental objectives into business planning and decision-making (Damert and Baumgartner, 2018;

Lozano, 2023). The literature therefore presents sustainability not simply as a technical response to emissions, but as a strategic management issue involving governance, investment, organisational capability, stakeholder relationships and adaptation to a changing external environment.

One prominent response is the integration of sustainability into **corporate governance and strategic management**. Effective carbon reduction requires environmental objectives to be embedded within organisational structures, investment decisions, risk management and long-term planning rather than treated as standalone environmental initiatives (Damert and Baumgartner, 2018; Lozano, 2023). Damert and Baumgartner (2018) identify formal environmental policies, carbon management systems, sustainability reporting and accountability mechanisms as important elements of corporate climate strategy. Such arrangements can provide continuity and clarify responsibility for sustainability performance. However, organisational approaches vary considerably. While some businesses adopt proactive strategies intended to create longer-term competitive value, others remain predominantly compliance-driven (Kim, 2022; Lozano, 2023). This variation suggests that the presence of environmental targets alone does not demonstrate strategic integration; their influence depends on the extent to which they shape actual organisational priorities and resource allocation.

Technological investment represents another major strategic response. Transportation businesses increasingly consider electric vehicles, hydrogen, biomethane, renewable energy integration and digital transport systems as pathways towards emissions reduction (Li et al., 2022; Damert and Baumgartner, 2018). However, as established in the preceding sections, technology adoption involves financial, infrastructure and operational uncertainties. Strategic technology adoption therefore requires more than purchasing low-carbon assets. Li et al. (2022) argue that fleet decarbonisation depends on long-term planning, investment capacity, infrastructure and organisational commitment. This implies that the strategic issue is not simply whether a technology can reduce emissions, but whether an organisation possesses the resources and capabilities to select, integrate and adapt that technology to its operating environment.

This capability dimension is strengthened by recent UK evidence. Gonzalez (2026), examining the electrification of UK transport, applies a Resource-Based View perspective to demonstrate how managerial capabilities can support the diffusion of sustainable technologies. The study highlights the role of organisations in developing and mobilising capabilities needed to coordinate actors, manage knowledge and facilitate technological transition. This extends earlier technology-focused perspectives by suggesting that differences in sustainability outcomes may arise not only from access to technologies but also from differences in how effectively organisations develop and

deploy the capabilities required to use them. In this sense, organisational capability becomes a strategic resource for decarbonisation rather than merely a supporting factor.

Collaboration and stakeholder engagement provide another response to constraints that individual firms cannot resolve independently. Transportation emissions arise across interconnected networks involving operators, manufacturers, infrastructure providers, suppliers, customers and government institutions. Businesses therefore increasingly participate in information sharing, coordinated transport planning, joint environmental programmes and collaborative sustainability initiatives (Bilek et al., 2024). Such approaches can enable organisations to pool knowledge and resources and address infrastructure or supply-chain constraints collectively. However, collaboration also creates dependencies because participating actors may have different commercial priorities, investment capacities and sustainability expectations. Its effectiveness therefore depends on coordination and alignment rather than collaboration being inherently beneficial.

Recent research further demonstrates the importance of this network perspective. Churchman et al. (2026), in the UK road-freight context, argue that rapid decarbonisation requires interaction between operators, policymakers, infrastructure providers, technology developers and other actors because critical transition decisions cannot be made effectively by individual organisations in isolation. This reinforces Bilek et al.'s (2024) collaborative perspective but extends it beyond supply-chain cooperation towards wider transition governance. The evidence therefore suggests that strategic business responses increasingly operate across organisational boundaries, particularly where infrastructure, technology standards and policy conditions are collectively determined.

Stakeholder management is closely related but extends beyond operational collaboration. Businesses must respond to regulators, customers, investors, employees and communities whose expectations can influence sustainability priorities (Kim, 2022; Lozano, 2023). Kim (2022) distinguishes between market-oriented responses, including technological and operational improvements, and non-market responses involving policy engagement, regulatory cooperation and stakeholder management. Combining these approaches allows businesses not only to adapt internally but also to engage with the institutional environment shaping their operations. This is particularly relevant where policy uncertainty or infrastructure dependency limits the effectiveness of unilateral organisational action.

Carbon management and performance measurement provide another strategic mechanism through which sustainability objectives can be translated into

organisational practice. Carbon accounting, emissions disclosure and environmental performance monitoring allow businesses to identify major emission sources, establish targets, assess interventions and demonstrate accountability (Damert and Baumgartner, 2018; Lozano, 2023). Steger-Jensen et al. (2025), however, highlight continuing difficulties in accurately calculating transport-related carbon footprints, particularly in logistics and last-mile operations. This introduces an important strategic limitation: organisations may adopt sustainability initiatives but struggle to establish whether the resulting reductions are being measured consistently or accurately. Carbon management should therefore be viewed not merely as a reporting exercise but as part of the information infrastructure required for evidence-based sustainability decisions.

Organisational adaptation and resilience constitute a further strategic response. Transportation businesses operate within changing technological, regulatory, environmental and market conditions, meaning that strategies developed under current conditions may require continuous adjustment. Adaptation can involve organisational learning, workforce development, supply-chain resilience, operational flexibility and climate-risk management (Unter et al., 2024; Lozano, 2023). This perspective shifts attention from implementing individual sustainability projects towards developing an organisation's longer-term ability to respond to change. It also creates an important connection between mitigation and adaptation: businesses must reduce their environmental impacts while simultaneously strengthening their capacity to operate under emerging climate, regulatory and market pressures.

The distinction between **mitigation and adaptation** nevertheless remains important. Mitigation-focused strategies directly target emissions through technology, operational improvement and carbon reduction initiatives, whereas adaptation focuses on organisational resilience to changing conditions. Unter et al. (2024) argue for greater integration between these approaches. From a business perspective, this is persuasive because concentrating exclusively on mitigation could leave organisations exposed to climate-related operational disruption, while adaptation without emissions reduction would do little to address the underlying sustainability challenge. The two approaches are therefore better understood as complementary components of long-term sustainability strategy rather than competing alternatives.

Overall, the literature demonstrates that transportation businesses respond to sustainability pressures through governance reform, technological investment, capability development, collaboration, stakeholder engagement, carbon management and organisational adaptation. However, these strategies are unlikely to operate effectively in isolation. Technological investment depends on financial and managerial capability; collaboration depends on stakeholder alignment; carbon management

depends on credible measurement; and organisational adaptation requires leadership, learning and resources. The effectiveness of strategic responses therefore appears to depend not simply on **which strategies businesses adopt, but on how coherently those strategies are combined and aligned with organisational capabilities and external conditions**. This reinforces the view that transportation decarbonisation is a strategic organisational transformation rather than a series of independent environmental interventions.

2.5 Conceptual Framework

The preceding literature demonstrates that sustainability and carbon footprint reduction within the transportation industry involve interactions between external sustainability pressures, carbon reduction strategies, implementation challenges, organisational resources and capabilities, strategic business responses and sustainability outcomes. Although these dimensions have been widely examined, they are often considered separately across technological, environmental, operational and policy-focused studies. A conceptual framework is therefore required to integrate these dimensions and provide a coherent analytical structure for examining how transportation businesses respond to sustainability pressures and the conditions influencing their carbon reduction efforts.

The framework developed for this study is informed primarily by **Stakeholder Theory and the Resource-Based View (RBV)**. These perspectives were selected because they provide complementary explanations of the external and internal factors influencing organisational responses to sustainability. Stakeholder Theory is relevant because transportation businesses operate within networks of regulators, customers, investors, employees, infrastructure providers, suppliers and communities whose expectations can influence environmental priorities and strategic decisions (**Freeman, 1984)**. Sustainability pressures therefore originate not only from formal regulation but also from the expectations and interests of stakeholders with the capacity to influence organisational behaviour. This perspective supports the framework's emphasis on external sustainability pressures and stakeholder relationships.

However, external pressure alone does not explain why organisations exposed to similar sustainability expectations may respond differently. The **Resource-Based View** provides an internal organisational perspective by emphasising the role of resources and capabilities in determining how firms respond to strategic challenges. Within transportation decarbonisation, these may include financial resources, managerial competence, technological knowledge, infrastructure access, organisational learning and the capacity to coordinate sustainability initiatives (**Barney, 1991)**. Recent evidence

from the UK transport sector supports the relevance of this perspective. Gonzalez (2026), examining transport electrification through an RBV lens, demonstrates the importance of managerial and organisational capabilities in facilitating the diffusion of sustainable technologies. The RBV therefore complements Stakeholder Theory by helping to explain why sustainability pressures may generate different strategic responses and outcomes across organisations.

The combination of these perspectives is appropriate for this study because neither external stakeholder pressures nor internal organisational resources alone adequately explain transportation decarbonisation. Stakeholder Theory helps explain **why businesses face pressure to act**, whereas the RBV contributes to understanding **their capacity to respond**. Their integration is particularly relevant to this research because transportation businesses must respond to environmental and regulatory expectations while simultaneously managing financial, technological, infrastructural and operational constraints. The conceptual framework consequently does not treat sustainability implementation as an automatic response to external pressure; instead, it recognises that organisational resources, capabilities and implementation conditions shape the strategies businesses are able to pursue.

Within the framework, **sustainability pressures** constitute the external context influencing organisational action. These include climate change concerns, national decarbonisation objectives, environmental regulation, customer expectations, investor demands and broader societal pressure for improved environmental performance (Jelti et al., 2023; Zhang, 2024). These pressures encourage transportation businesses to consider carbon reduction strategies including fleet electrification, alternative fuels, operational efficiency, green logistics and carbon management.

The implementation of such strategies is, however, affected by **business challenges**. Financial constraints, technological uncertainty, infrastructure limitations, regulatory complexity, stakeholder conflicts and operational pressures can restrict the ability of organisations to translate sustainability intentions into effective action (Karam et al., 2023; Kervall and Pålsson, 2023; Neagoe et al., 2024). These challenges occupy a central position within the framework because they help explain the potential gap between sustainability ambition and implementation. Viewed through an RBV perspective, they may also expose differences in the resources and capabilities available to individual organisations.

Businesses respond to these constraints through **strategic organisational actions**, including sustainability governance, technological investment, carbon management, collaboration, stakeholder engagement, organisational learning and resilience-building

(Damert and Baumgartner, 2018; Kim, 2022; Bilek et al., 2024). These responses represent the mechanisms through which businesses attempt to reconcile environmental expectations with operational and commercial requirements. Their effectiveness is therefore likely to depend not merely on the selection of a particular strategy, but on the organisation's ability to combine appropriate resources, capabilities and stakeholder relationships.

The final component concerns **carbon reduction and broader sustainability outcomes**. Successful strategic responses may contribute to reduced greenhouse gas emissions, improved resource efficiency, enhanced environmental performance and progress towards organisational sustainability objectives. However, outcomes may vary according to technological readiness, financial capacity, infrastructure availability, organisational capabilities and regulatory support (Li et al., 2022; Lozano, 2023). The framework therefore avoids assuming that adopting a sustainability strategy automatically produces successful carbon reduction outcomes.

Importantly, the framework is intended as an **analytical rather than causal model**. As this study employs a systematic literature review rather than primary empirical testing, it does not seek to establish statistical causal relationships between the framework's components. Instead, the framework provides a structure for synthesising evidence concerning the pressures confronting transportation businesses, the barriers affecting implementation, the strategic responses adopted and the reported effectiveness of those responses. This distinction is important because it aligns the theoretical framework with the methodological design of the study.

The framework also directly supports the research objectives. **Objective 1**, which examines sustainability issues and carbon footprint concerns within UK transportation, is reflected in sustainability pressures and carbon reduction strategies. **Objective 2** is represented by the financial, technological, infrastructural, regulatory, organisational and operational challenges affecting implementation. **Objective 3** is addressed through the strategic responses adopted by businesses, while **Objective 4** concerns the reported effectiveness of those responses and their contribution to carbon reduction outcomes. The framework therefore provides a direct conceptual connection between the research problem, literature review, research objectives and subsequent analysis.

Accordingly, the framework guides the thematic synthesis of the reviewed literature rather than functioning only as a diagrammatic summary of Chapter 2. Evidence identified through the systematic review will be examined in relation to the principal analytical domains of **sustainability pressures and carbon reduction strategies, implementation challenges, strategic business responses, and carbon reduction**

outcomes. Relationships and tensions between these domains will also be considered, particularly where organisational capabilities or stakeholder conditions appear to influence implementation. This approach enables the analysis to move beyond describing individual sustainability initiatives towards examining how challenges, organisational responses and outcomes interact within the UK transportation context.

Overall, the conceptual framework proposes that transportation decarbonisation emerges from the interaction between **external sustainability pressures and internal organisational capacity**. Businesses respond to sustainability expectations through carbon reduction strategies, but implementation is conditioned by financial, technological, infrastructural, regulatory and organisational challenges. Strategic responses and organisational capabilities subsequently influence the extent to which these challenges can be managed and sustainability objectives pursued. The integration of Stakeholder Theory and RBV therefore provides an appropriate theoretical foundation for examining transportation sustainability as both an externally driven transition and an organisational strategic challenge.

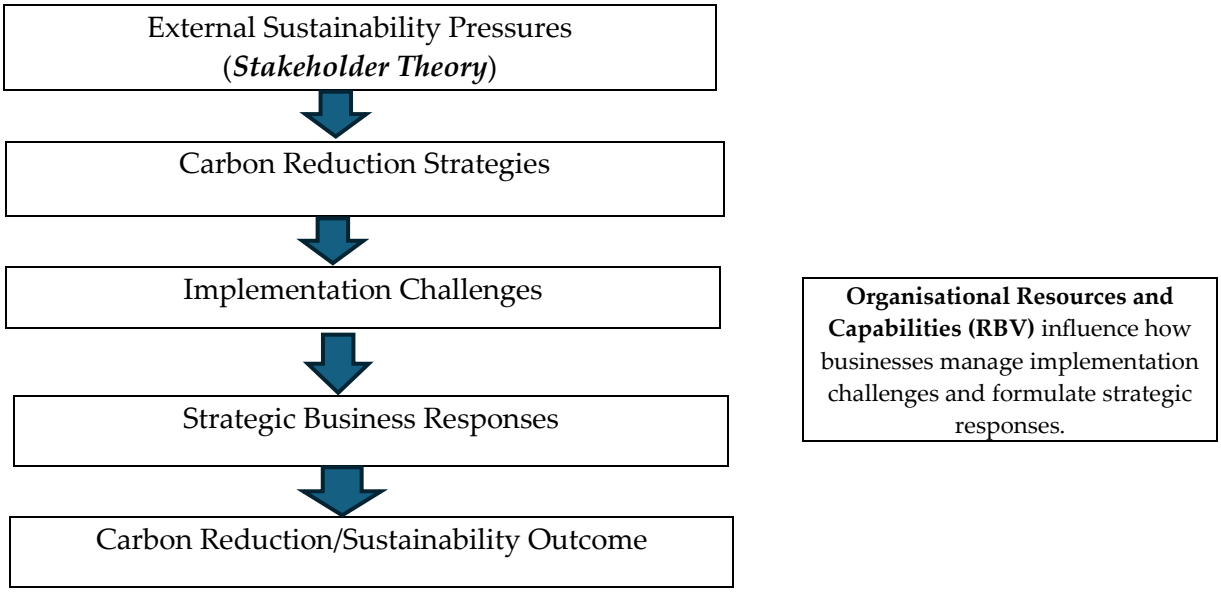


Fig. 2.1: Conceptual Framework for Sustainability and Carbon Footprint Reduction in the UK Transportation Industry.

2.6 Research Gaps

The preceding review of literature demonstrates that significant progress has been made in understanding transportation sustainability, carbon reduction strategies, implementation challenges, and organisational responses. Existing studies have contributed valuable insights into transportation emissions, low-carbon technologies, green logistics practices, sustainability governance, and climate-related business strategies (Brand et al., 2012; Herold and Lee, 2017; Lozano, 2023). More recent research has extended this knowledge by examining infrastructure requirements, transport management systems, decarbonisation costs, organisational capabilities, operational decision-making, and transition governance (Alam et al., 2025; Blokus-Dziula and Dziula, 2026; Churchman et al., 2026; Gonzalez, 2026). However, despite the increasing breadth and sophistication of research in this field, several important gaps remain.

A key limitation of existing research is the fragmented nature of transportation sustainability studies. Much of the literature examines sustainability from distinct technological, environmental, policy, economic, or operational perspectives. For example, studies focusing on transportation sustainability frequently emphasise life-cycle assessments, emissions measurement, electric vehicle adoption, and alternative fuel technologies (Zhang, 2024; Oliveri et al., 2023). Recent evidence suggests that this pattern continues. Blokus-Dziula and Dziula (2026), in their review of 135 studies published between 2022 and 2026, identify substantial research activity relating to low-emission transport technologies, infrastructure, transport management systems, policy, and decarbonisation costs. However, they also highlight comparatively weaker attention to human and social dimensions. Similarly, Churchman et al. (2026) observe that road-freight decarbonisation research remains strongly dominated by techno-economic perspectives, while socio-technical and political dimensions are less developed. These findings suggest that the limitation is not an absence of transportation decarbonisation research, but rather the uneven development and limited integration of its different dimensions.

Similarly, research on carbon reduction strategies has largely concentrated on the effectiveness of particular interventions rather than the organisational processes through which such interventions are selected, implemented, adapted, and sustained. Existing studies commonly assess the environmental benefits of electric vehicles, route optimisation, green logistics, and alternative fuel technologies (Teoh et al., 2018; Li et al., 2022). Zhang (2024), for example, demonstrates how demand-side freight adjustments, renewable electricity supply, and alternative energy interventions can influence transportation decarbonisation across G20 economies. However, such macro-level modelling provides limited insight into the organisational decision-making

processes through which transportation businesses evaluate and implement these interventions. This reinforces the continuing need to connect technological and system-level discussions with broader business strategy and organisational management perspectives.

Another important gap concerns the relationship between sustainability challenges and strategic business responses. Existing literature identifies numerous barriers affecting transportation sustainability, including financial constraints, technological uncertainty, infrastructure limitations, regulatory complexity, and stakeholder conflicts (Jelti et al., 2023; Karam et al., 2023; Neagoe et al., 2024). Recent research reinforces the significance of these challenges. Alam et al. (2025), for example, identify policy, technical, and infrastructure barriers as major constraints on road transport decarbonisation, while profitable return on investment, government subsidies, and financial support emerge as important drivers. Churchman et al. (2026) similarly demonstrate that UK road-freight operators face substantial financial and operational risks where adopting low-carbon technologies could disadvantage them competitively relative to operators that delay transition. However, although the literature increasingly identifies both barriers and drivers, these factors are frequently analysed separately from the wider organisational responses businesses develop to manage them. Consequently, there remains scope for greater understanding of how interacting challenges shape strategic choices and how those responses influence sustainability outcomes.

The review also reveals continuing debate regarding the most effective pathway towards transportation sustainability. Some researchers advocate technology-led approaches centred on electric vehicles, alternative fuels, and digital transport systems (Oliveri et al., 2023; Li et al., 2022), while others argue that technological innovation alone is insufficient without broader organisational, behavioural, and policy transformation (Brand et al., 2012; Lozano, 2023). Similarly, debates persist regarding the relative importance of mitigation-focused strategies compared with adaptation and resilience-building approaches (Unter et al., 2024). Recent studies reinforce the need for a more integrated perspective. Bamigbe et al. (2026), for example, demonstrate that freight decarbonisation decisions depend simultaneously on technology performance, infrastructure readiness, costs, energy systems, and policy constraints. Churchman et al. (2026) likewise argue that technically feasible solutions alone are insufficient because effective transition depends upon coordination between operators, infrastructure providers, vehicle manufacturers, policymakers, and other actors. These differing perspectives suggest that transportation sustainability cannot be adequately understood through isolated technological or policy interventions.

A further gap relates to the growing recognition of businesses as central actors within transportation decarbonisation. Although governments, regulators, researchers, and infrastructure providers play important roles in shaping sustainability agendas, implementation ultimately requires organisational decisions relating to investment, resources, technology adoption, operational restructuring, collaboration, and long-term strategy. Earlier research frequently concentrated more heavily on policy development, technological innovation, and environmental outcomes than on the strategic actions of businesses themselves (Damert and Baumgartner, 2018; Kim, 2022). Recent research has begun to address this organisational dimension, but often through narrowly defined mechanisms. Gonzalez (2026), for instance, demonstrates the importance of managerial capabilities and transition intermediaries in accelerating battery-electric vehicle diffusion in the UK and argues that capabilities have remained relatively marginal within sustainability-transition research. Similarly, Alozade et al. (2026) use dynamic capabilities and stakeholder theory to explain how organisations can combine sustainability objectives with operational improvement. These studies represent important developments, but their focus on particular capabilities, technologies, or organisational frameworks indicates that the wider strategic management dimension of transportation sustainability remains comparatively fragmented.

The literature also demonstrates a tendency to examine transportation subsectors and technologies in isolation. Several studies focus specifically on urban freight systems, logistics operations, electric vehicle deployment, public transportation systems, or supply chain sustainability (Kervall and Pålsson, 2023; Bilek et al., 2024). This tendency is also evident within the most recent UK literature. Churchman et al. (2026) concentrate specifically on road freight, Gonzalez (2026) examines battery-electric vehicle diffusion, and Bamigbe et al. (2026) investigate food-freight decarbonisation within Lincolnshire. While these studies generate valuable and context-rich insights, their findings are necessarily bounded by particular transport modes, technologies, geographical areas, or transition mechanisms. Consequently, there remains value in a broader synthesis capable of examining common sustainability challenges and organisational responses across the wider transportation context.

The geographical context of existing research presents a related limitation. Much of the literature adopts global perspectives or focuses on particular countries, regions, and urban environments. Studies such as Alam et al. (2025), for example, provide valuable evidence on barriers and drivers within Bangladesh, while Zhang (2024) examines freight decarbonisation across G20 countries. Such evidence can contribute important comparative insights but cannot automatically be transferred to the UK because regulatory structures, infrastructure maturity, financial conditions, stakeholder arrangements, and organisational practices vary between national contexts. At the same

time, the presence of recent UK studies means that it would no longer be accurate to suggest that UK transportation decarbonisation itself is insufficiently researched. Rather, the gap lies in the fact that UK evidence remains distributed across specific subsectors, technologies, regions, and analytical perspectives. This creates a need for greater synthesis of business-centred evidence within the specific regulatory, economic, and organisational context of UK transportation.

Another emerging issue concerns the measurement and evaluation of carbon reduction outcomes. Steger-Jensen et al. (2025) demonstrate that logistics operators face increasing pressure to calculate, document, and report actual transportation emissions accurately. Their research highlights continuing challenges associated with carbon-footprint calculation, transport planning, and the consistency of emissions reporting in last-mile logistics. This is particularly important because the adoption of a sustainability strategy does not itself demonstrate environmental effectiveness. Businesses must also be able to establish whether implemented strategies produce measurable reductions in emissions and whether these benefits can be sustained while maintaining operational and commercial performance. The relationship between strategic response, implementation conditions, and measurable sustainability outcomes therefore requires greater integration within transportation sustainability research.

Drawing on the conceptual framework developed in this study, the review therefore identifies an important relationship gap between sustainability pressures, implementation challenges, strategic organisational responses, and carbon reduction outcomes. Previous research has generated substantial knowledge regarding individual components of transportation sustainability, and more recent studies increasingly recognise organisational, managerial, social, and political dimensions. Nevertheless, these elements are often examined separately or within narrowly defined transport contexts. Comparatively limited research brings these dimensions together to examine how interacting financial, technological, infrastructural, regulatory, operational, and organisational challenges influence the strategic responses adopted by transportation businesses and the effectiveness of resulting carbon reduction initiatives.

Therefore, the principal research gap identified by this study is **not an absence of research on transportation decarbonisation, business barriers, or UK transport sustainability individually, but the limited integrated understanding of how these elements interact from a strategic business perspective within the UK transportation context**. Existing literature remains dispersed across technologies, transport modes, geographical settings, policy perspectives, individual barriers, and specific organisational mechanisms. By systematically synthesising evidence on sustainability pressures, implementation challenges, strategic organisational responses, and carbon

reduction outcomes, this study seeks to address this fragmentation and contribute a more integrated, business-centred understanding of transportation sustainability and carbon footprint reduction in the United Kingdom.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter explains and justifies the methodology adopted to investigate sustainability and carbon footprint reduction within the UK transportation industry. It outlines the philosophical position, research approach and research design underpinning the study and explains the procedures used to identify, select, analyse and synthesise relevant academic literature. The methodological choices were guided by the research aim and objectives, which require an understanding of sustainability challenges, carbon reduction strategies, organisational responses and reported outcomes rather than the statistical testing of predetermined relationships.

Given the nature of the research problem, the study adopts a qualitative secondary research design using a Systematic Literature Review (SLR). This approach enables evidence from different areas of transportation, sustainability and business research to be systematically brought together and critically interpreted. The chapter therefore explains the research philosophy and approach before discussing the SLR design, search strategy, inclusion and exclusion criteria, study-selection process, data extraction and thematic analysis. It concludes by considering the quality, limitations and ethical implications of the methodological approach.

3.2 Research Philosophy

Research philosophy concerns the assumptions that guide how knowledge is understood, developed and interpreted within a study (Saunders et al., 2023). The selection of an appropriate philosophical position is important because it should be consistent with the nature of the research questions, the form of evidence being examined and the analytical approach used.

This study is principally informed by an **interpretivist philosophy**. Interpretivism is appropriate where research seeks to understand meanings, perspectives and context rather than establish universal relationships through numerical measurement. The present study does not seek to statistically test whether a particular carbon reduction strategy causes a predetermined level of emissions reduction. Instead, it seeks to

interpret and synthesise how existing research explains sustainability pressures, implementation challenges and the strategic responses adopted by transportation businesses.

An interpretivist position is particularly appropriate because transportation sustainability is influenced by different organisational, technological, economic, regulatory and geographical contexts. For example, the significance of infrastructure limitations, investment costs or stakeholder pressures may differ between freight operators, public transport systems and logistics businesses. Similarly, strategic responses may vary according to organisational resources, capabilities and external conditions. These differences mean that evidence cannot always be understood independently of the context in which it was generated. The study therefore seeks to identify patterns across the literature while recognising variation and competing interpretations between studies.

The interpretivist position is also consistent with the study's use of qualitative thematic analysis. Rather than aggregating numerical effect sizes, the research interprets published findings to identify recurring themes, relationships, areas of agreement and disagreement. This enables the analysis to examine not only **what** challenges and strategies are reported, but also **how** the literature explains their significance for transportation businesses. The philosophy therefore provides a coherent foundation for the qualitative and interpretive nature of the systematic review.

3.3 Research Approach

The study adopts a predominantly **inductive research approach**. Inductive reasoning involves developing broader patterns, themes and interpretations from the evidence rather than beginning with predetermined hypotheses that must be statistically tested (Saunders et al., 2023). This approach is appropriate because the research seeks to synthesise a diverse body of literature and establish recurring patterns concerning transportation sustainability, implementation challenges and organisational responses.

The inductive orientation is reflected in the thematic-analysis process. The principal themes were developed through repeated engagement with the selected literature and the identification and grouping of recurring concepts rather than through the testing of predetermined hypotheses. This allows the findings to remain grounded in the reviewed evidence and provides sufficient flexibility to accommodate unexpected relationships, contradictions and context-specific findings.

However, the analysis is not entirely theory-free. The conceptual framework developed in Chapter Two, informed by Stakeholder Theory and the Resource-Based View, provides an interpretive lens for examining relationships between external sustainability pressures, organisational resources and capabilities, implementation challenges, strategic responses and sustainability outcomes. The study therefore remains predominantly inductive in identifying and synthesising themes while using the conceptual framework to support their subsequent interpretation. This prevents the theoretical framework from predetermining the findings while still allowing established theory to assist in explaining the patterns identified.

This approach is particularly suitable for the research objectives because the study seeks to identify sustainability concerns and carbon reduction strategies, examine implementation challenges, explore organisational responses and evaluate reported outcomes across a heterogeneous body of literature. An inductive approach enables these dimensions to be synthesised without assuming in advance that one particular technology, barrier or strategic response will dominate the evidence.

3.4 Research Design and Justification of the Systematic Literature Review

Research design provides the overall structure through which research questions are addressed and evidence is collected and analysed (Saunders et al., 2023). Given the objectives of this study, a **qualitative secondary research design based on a Systematic Literature Review** was selected.

A qualitative design is appropriate because the research questions are concerned primarily with understanding themes, challenges, organisational responses and relationships rather than measuring variables or testing statistical hypotheses. Qualitative synthesis enables findings from studies employing different methodologies and investigating different transportation contexts to be compared and interpreted within a common analytical structure (Creswell and Creswell, 2018). This is particularly valuable for transportation sustainability, where relevant knowledge spans business management, logistics, environmental management, transportation studies and sustainability research.

The study relies exclusively on **secondary data from published academic literature**. This decision is consistent with the purpose of the research. Transportation sustainability and decarbonisation have generated a substantial body of research examining technologies, policy interventions, business challenges and organisational

practices. Secondary research therefore provides access to evidence drawn from a wider range of transportation contexts than could realistically be investigated through a small primary study. It also enables comparison between different perspectives and identification of areas where findings converge, conflict or remain fragmented.

Within this secondary design, an SLR was selected because it provides a structured and transparent process for identifying, selecting, evaluating and synthesising existing research (Tranfield et al., 2003). Unlike a traditional narrative review, an SLR requires explicit search procedures and eligibility criteria, thereby improving transparency and reducing the risk that studies are selected solely because they support a preferred argument. Systematic reviews are also particularly useful where a body of knowledge is dispersed and requires synthesis to identify patterns, debates and research gaps (Snyder, 2019).

The SLR is particularly appropriate to the present research problem because relevant evidence is fragmented across several disciplinary areas. Research concerning low-carbon technologies may not directly engage with organisational strategy, while business-management studies may examine sustainability governance without concentrating specifically on transportation technologies. A systematic review enables these different evidence streams to be brought together and examined against the study's integrated conceptual framework. This directly supports the principal research gap identified in Chapter Two: the need for greater integration between sustainability pressures, implementation challenges, strategic organisational responses and carbon reduction outcomes within the UK transportation context.

The design also aligns directly with the research objectives. Evidence concerning transportation sustainability and carbon reduction strategies addresses Objective 1; evidence concerning financial, technological, infrastructural, regulatory, organisational and operational barriers addresses Objective 2; literature examining governance, innovation, collaboration and organisational adaptation supports Objective 3; and reported environmental and organisational outcomes provide evidence for evaluating Objective 4. The SLR therefore functions not simply as a convenient method of gathering literature, but as a research design specifically suited to answering the study's research questions.

Nevertheless, an SLR does not eliminate researcher judgement. Decisions concerning search terminology, eligibility criteria, coding and interpretation can influence the resulting synthesis. The systematic design is therefore intended to make those decisions **explicit, transparent and reproducible**, rather than suggesting that qualitative synthesis

can be entirely objective. This consideration informs the search, screening, data extraction and thematic-analysis procedures described in the subsequent sections.

3.5 Search Strategy and Data Collection

A structured search strategy was developed to identify literature relevant to sustainability and carbon footprint reduction within the transportation industry. The search process was guided by the research aim, objectives and research questions and was designed to capture literature addressing four interconnected areas: transportation sustainability, carbon reduction strategies, implementation challenges and strategic organisational responses. A systematic search procedure was considered important because relevant evidence is distributed across several disciplinary areas, including transportation studies, environmental management, logistics, supply-chain management and business strategy.

Three principal academic databases were used for the literature search: **Web of Science, Scopus and ProQuest**. The use of multiple databases was intended to broaden the coverage of the search and reduce dependence on the indexing characteristics of any single database. Web of Science and Scopus were selected because of their extensive coverage of peer-reviewed multidisciplinary research and their relevance to transportation, sustainability and environmental studies. ProQuest complemented these databases through its coverage of business, management and related interdisciplinary literature. The combination was therefore appropriate to the multidisciplinary nature of the research problem and its particular emphasis on both transportation sustainability and organisational strategy.

The search process combined keywords relating to the principal concepts within the research questions. Boolean operators such as **AND** and **OR** were used to connect related terms and accommodate variations in terminology across the literature. The broad search combined terms relating to sustainability, carbon emissions, transportation and business, while additional searches targeted specific themes including implementation challenges, carbon reduction strategies, strategic responses and the UK transportation context. This approach provided sufficient breadth to identify relevant studies while maintaining alignment with the research objectives.

The principal search strings used during the review are presented in Table 3.5.1.

Table 3.5.1 Search Strings Used in the Literature Search

Search Purpose	Search String

Main Search String	*(sustainability OR "environmental sustainability" OR "corporate sustainability") AND ("carbon footprint" OR "carbon emissions" OR "greenhouse gas emissions") AND (transport OR transportation OR logistics OR "freight transport") AND (business OR firm OR company OR corporate)*
Sustainability Theme	*(sustainability OR "corporate sustainability" OR "environmental sustainability") AND ("carbon footprint" OR "carbon emissions") AND (transport OR transportation OR logistics) AND (business OR firms OR companies)*
Challenges Theme	*("climate change" OR decarbonisation OR "net zero") AND (transport OR transportation OR logistics) AND (business OR corporate OR firms) AND (challenges OR barriers)*
Strategic Responses Theme	*(sustainability OR "carbon reduction") AND (transportation OR logistics OR freight) AND (business OR firms) AND (strategy OR "strategic response" OR "sustainability strategy")*
UK Context Theme	*("carbon emissions" OR decarbonisation) AND (transport OR transportation OR logistics) AND (business OR firms) AND ("United Kingdom" OR UK)*

Source: Author's search strategy

These search strings were adapted where necessary to accommodate differences in the search interfaces and indexing conventions of Web of Science, Scopus and ProQuest. The purpose was therefore not to reproduce an identical technical query across all three databases, but to maintain consistency in the underlying concepts being searched.

The review primarily focused on literature published between **2015 and 2026**, reflecting the period during which transportation decarbonisation has received increasing attention due to technological development, net-zero commitments and growing business sustainability expectations. However, earlier studies were retained where they provided important theoretical, conceptual or foundational contributions to the research. This explains the inclusion of relevant earlier literature such as Brand et al. (2012), while ensuring that the review remained informed by contemporary evidence. Particular attention was also given during the final updating stage to literature published between **2022 and 2026** to strengthen the academic currency of the study.

Filters were applied to improve the relevance and quality of retrieved literature. Priority was given to **peer-reviewed journal articles and review papers published in English**. Where database functionality permitted, relevant research areas including Business, Management, Environmental Studies, Transportation, Sustainability and related fields were selected. The filtering process was sufficiently broad to avoid excluding relevant

interdisciplinary studies while reducing records with little connection to the research objectives.

The database searches initially generated a considerably larger body of literature than could appropriately contribute to the final review. Consequently, study identification proceeded through sequential screening. Titles and abstracts were first examined to determine their relevance to transportation sustainability, carbon reduction, implementation challenges and organisational responses. Studies that demonstrated sufficient relevance were retained for further consideration, after which full-text assessment was undertaken to determine their methodological quality and contribution to the research objectives. The existing review process also incorporated duplicate removal and was informed by PRISMA principles to improve transparency and consistency.

The search strategy was intentionally designed to accommodate both **UK-specific and internationally relevant evidence**. UK-focused studies were particularly important because the research examines transportation businesses within the United Kingdom. However, restricting the search exclusively to studies containing UK terminology could have excluded important theoretical, technological and organisational evidence relevant to the research problem. International studies were therefore retained where their findings provided transferable insights into transportation decarbonisation, business challenges or strategic responses. Their applicability to the UK context was subsequently considered during analysis rather than assumed automatically.

The final evidence base consisted predominantly of peer-reviewed academic literature covering transportation contexts including freight and logistics, public transportation, sustainable mobility and transportation management. This breadth was necessary because the study investigates sustainability and carbon reduction across the transportation industry rather than limiting the analysis to a single technology or transport subsector.

Overall, the use of multiple academic databases, structured Boolean searches, publication and subject filters, sequential screening and full-text assessment provided a transparent procedure for identifying relevant literature. The search strategy was sufficiently broad to capture the multidisciplinary nature of transportation sustainability while remaining focused on the business and organisational dimensions

central to the research questions. The subsequent application of predefined inclusion and exclusion criteria provided the next stage for determining which studies were retained within the final review.

3.6 Inclusion and Exclusion Criteria

Following the database searches, predefined inclusion and exclusion criteria were applied to determine which studies were sufficiently relevant and appropriate for the systematic review. Establishing eligibility criteria before final study selection was important for improving consistency and transparency and reducing the risk that literature would be included solely because it supported particular assumptions or conclusions. The criteria were developed in accordance with the research aim and objectives and were intended to balance methodological quality, relevance to the UK transportation context and sufficient breadth to capture the multidisciplinary nature of transportation sustainability.

Studies were included where they examined one or more of the central areas of the research: **transportation sustainability, carbon footprint or emissions reduction, implementation challenges, carbon reduction strategies, or strategic and organisational responses by businesses**. Particular priority was given to studies addressing transportation from a business, management, logistics or organisational perspective. However, relevant technological, environmental and policy-focused studies were also included where their findings contributed directly to understanding the conditions under which transportation businesses pursue decarbonisation.

The review primarily included **peer-reviewed journal articles and review papers** because peer review provides an established level of academic quality control and strengthens the credibility of the evidence base. Studies were required to be available in English to ensure that they could be consistently interpreted and analysed by the researcher. Literature that did not provide sufficient substantive evidence to address the research questions, such as opinion pieces, promotional material and non-academic commentary, was excluded.

The principal publication period was **2015–2026**. This period was selected to capture contemporary developments in transportation decarbonisation, including technological change, increasing net-zero commitments, evolving environmental regulation and greater organisational attention to sustainability. Nevertheless, earlier studies were retained selectively where they provided important theoretical, conceptual or foundational contributions that remained relevant to the research. This approach enabled the review to retain influential earlier scholarship while ensuring that the

principal evidence base reflected contemporary transportation sustainability research. Particular attention was given to recent studies published between **2022 and 2026** during the final literature-update stage to strengthen the academic currency of the review.

Although the study focuses specifically on the **UK transportation industry**, geographical location was not applied as an absolute exclusion criterion. UK-based research was prioritised where available because it reflects the regulatory, infrastructural and organisational environment most directly relevant to the study. However, international studies were included where they provided theoretically or empirically relevant evidence concerning carbon reduction technologies, implementation barriers, organisational strategies or sustainability outcomes that could inform understanding of the UK context. The applicability of such findings to the UK was critically considered during analysis rather than assumed. This was important because restricting the review exclusively to UK studies could have excluded significant developments within the wider transportation sustainability literature.

Table 3.6.1 Inclusion and Exclusion Criteria.

Criterion	Inclusion Criteria	Exclusion Criteria
Subject relevance	Studies addressing transportation sustainability, carbon emissions or carbon footprint reduction, decarbonisation strategies, implementation challenges or organisational/business responses	Studies with no substantive connection to transportation sustainability, decarbonisation or the research objectives
Sector relevance	Freight, logistics, passenger/public transport, sustainable mobility, transportation management and related transportation activities	Studies unrelated to transportation or whose findings had no meaningful relevance to transportation businesses
Business relevance	Studies examining or informing organisational strategy, implementation, operations, management, investment, stakeholder relationships or business sustainability	Purely technical studies where no relevant implications for implementation, organisations or transportation sustainability could be identified
Geographical relevance	UK studies prioritised; international studies included where findings provided relevant comparative, theoretical or transferable insights	International studies with highly context-specific findings and no clear relevance to the UK transportation context
Publication type	Peer-reviewed journal articles and scholarly review papers	Opinion pieces, promotional material, blogs, news articles and other non-scholarly sources

Publication period	Primarily 2015–2026; earlier seminal or theoretically significant studies retained where justified	Older studies with no continuing theoretical, conceptual or empirical relevance
Language	English-language publications	Publications unavailable in English
Accessibility	Full text available through university databases, open-access sources or other legitimate academic access	Studies for which sufficient full-text material could not be obtained for reliable assessment
Analytical relevance	Studies containing sufficient findings or discussion to contribute to one or more research objectives	Studies mentioning sustainability or transportation only superficially without evidence relevant to the research questions

Source: Author's inclusion and exclusion criteria.

The criteria were applied progressively during the screening process. Initial decisions were made through titles and abstracts, with obviously irrelevant records excluded at this stage. Potentially relevant studies were subsequently subjected to full-text assessment, allowing closer examination of their methodological quality, substantive findings and relevance to the research objectives. Where a study addressed transportation sustainability but was predominantly technical, it was retained only where its findings had identifiable implications for business implementation, operational decision-making or carbon reduction strategy.

The application of these criteria also helped maintain alignment between the literature sample and the conceptual framework developed in Chapter Two. Studies contributing evidence concerning **sustainability pressures and carbon reduction strategies, implementation challenges, strategic organisational responses or carbon reduction outcomes** were particularly relevant because these dimensions provide the analytical structure through which the literature is subsequently synthesised. Nevertheless, the criteria were not used to force studies into predetermined theoretical categories; relevant findings outside these areas remained eligible where they contributed meaningfully to answering the research questions.

Overall, the inclusion and exclusion criteria provided a systematic basis for moving from the broader search results to a focused and academically credible evidence base. By combining relevance, academic quality, recency, geographical applicability and sufficient analytical depth, the criteria supported a selection process capable of addressing the research objectives while maintaining transparency regarding the boundaries of the review.

3.7 Sample Selection and Study Justification

Following the application of the search strategy and inclusion and exclusion criteria, a structured study-selection process was undertaken to identify the literature that formed the final evidence base for the review. The initial database searches generated a substantial number of potentially relevant records. Titles and abstracts were first screened against the predefined eligibility criteria, after which studies that appeared relevant were retained for full-text assessment. Duplicate records identified across the databases were removed, while studies that did not sufficiently address transportation sustainability, carbon reduction, business challenges or organisational responses were excluded. The screening process was informed by the principles of the PRISMA framework to improve transparency and consistency in the selection of studies (**Page et al., 2021)**.

The final selection was therefore not based on a predetermined numerical target alone, but on the **relevance, quality and contribution of each study to the research objectives**. Particular emphasis was placed on literature examining transportation sustainability from a business or organisational perspective, while technical and policy studies were retained where they contributed directly to understanding implementation challenges, carbon reduction strategies or strategic responses. This approach ensured that the final sample remained sufficiently focused while still representing the multidisciplinary nature of transportation sustainability.

The final review comprised **16 studies** that met the eligibility criteria and provided sufficient evidence for thematic analysis. The selected studies represented a range of transportation contexts, including freight transport, logistics, public transportation, sustainable mobility and transportation management. This diversity was considered important because the purpose of the study was not to examine a single transportation mode or technology, but to identify recurring sustainability challenges and strategic organisational responses across the wider transportation sector.

The adequacy of the final sample was judged in relation to the **research objectives and analytical depth rather than statistical representativeness**. Because the study adopts a qualitative systematic literature review, the objective is not to generate statistically generalisable estimates from a probabilistic sample. Instead, the 16 selected studies were expected to provide sufficient conceptual and empirical coverage to identify recurring themes, compare different perspectives and examine relationships between sustainability pressures, implementation challenges, strategic responses and reported outcomes. The application of clearly defined eligibility criteria resulted in a focused body of literature considered sufficiently diverse to address the research objectives.

This sampling approach nevertheless has limitations. First, restricting the review primarily to peer-reviewed, English-language literature may exclude relevant evidence published in other languages or outside academic journals. The eligibility criteria also prioritised literature with direct transportation and business relevance, meaning that potentially useful technical studies may have been excluded where their organisational implications were not sufficiently clear. Furthermore, although the study focuses on the UK transportation context, some international studies were retained where they provided relevant comparative evidence. Differences in regulatory systems, infrastructure maturity and business environments mean that findings from such studies cannot automatically be generalised to UK transportation businesses.

A further limitation concerns the breadth of the transportation sector itself. The selected studies cover different transport modes, technologies and organisational settings, which strengthens the breadth of the synthesis but may also introduce contextual heterogeneity. Findings that apply strongly to road freight, for example, may not apply in the same way to passenger transport or other subsectors. The thematic analysis therefore considers both recurring cross-sector patterns and important contextual differences rather than assuming uniformity across the industry.

Overall, the study-selection process sought to balance **rigour, relevance and breadth**. The combination of systematic screening, predefined inclusion and exclusion criteria, full-text assessment and cross-sector representation provided an evidence base capable of supporting the qualitative thematic analysis. At the same time, acknowledging the limitations of the sampling process strengthens transparency and helps define the boundaries within which the findings should be interpreted.

3.8 Data Analysis

Following study selection and data extraction, the included literature was analysed using **thematic analysis**, a qualitative method for identifying, organising and interpreting recurring patterns within a dataset (Braun and Clarke, 2006). The method was appropriate because the review incorporated studies from different transportation contexts and research disciplines, requiring an analytical approach capable of synthesising heterogeneous qualitative evidence rather than statistically aggregating findings.

The analysis followed Braun and Clarke's (2006) **six-phase framework**. First, the selected studies were read repeatedly to develop familiarity with their findings, with particular attention to sustainability concerns, carbon reduction initiatives, implementation barriers, organisational responses and reported outcomes. Second,

recurring concepts were assigned initial codes, such as financial constraints, infrastructure limitations, technological uncertainty, fleet electrification, collaboration and sustainability governance. Third, related codes were grouped into broader categories from which candidate themes were developed.

The fourth phase involved reviewing and refining these themes against the underlying evidence, consolidating overlapping concepts while retaining important differences between studies. During the fifth phase, the themes were clearly defined and named according to their contribution to the research problem. The final phase involved synthesising findings across studies to identify areas of agreement, disagreement and contextual variation. This enabled the analysis to move beyond summarising individual studies towards examining relationships between sustainability challenges, strategic responses and reported outcomes.

Four principal themes emerged from this process: **Sustainability in Transportation; Carbon Reduction Strategies; Challenges Faced by Businesses; and Strategic Responses by Businesses**. These themes were not predetermined but developed through repeated engagement with the literature and the identification of recurring patterns, consistent with the predominantly inductive approach adopted in this study.

The thematic analysis was also aligned directly with the research objectives. **Objective 1** was addressed through evidence relating to transportation sustainability and carbon reduction strategies, including low-carbon technologies, alternative fuels, operational efficiency and green logistics. **Objective 2** was examined through financial, technological, infrastructural, regulatory, organisational and operational barriers. **Objective 3** focused on strategic business responses, including governance, technological investment, collaboration, stakeholder engagement and organisational adaptation. **Objective 4** required cross-theme comparison of strategies, implementation challenges and reported outcomes to assess their effectiveness and contribution to carbon reduction.

Effectiveness was not assessed solely according to how frequently a strategy appeared in the literature. Reported outcomes were considered alongside the organisational and contextual conditions affecting implementation. This was important because a strategy may demonstrate significant emissions-reduction potential while facing financial, technological or infrastructure constraints that limit its practical application. The analysis therefore considered both the potential benefits of identified strategies and the conditions influencing their implementation.

The conceptual framework developed in Chapter Two supported the later interpretation of the findings. Stakeholder Theory assisted in interpreting external sustainability pressures, while the Resource-Based View supported consideration of how organisational resources and capabilities influence the management of implementation challenges and strategic responses. However, these theoretical perspectives were used primarily to interpret the emerging findings rather than impose predetermined themes, maintaining consistency with the study's predominantly inductive approach.

Overall, the analytical process progressed from **data extraction and coding to theme development, cross-study comparison and theoretical interpretation**. This provided a systematic basis for answering the research questions while allowing areas of agreement, disagreement and contextual variation within the literature to remain visible.

Table 3.8.1: Themes Identified Through Thematic Analysis

Theme	Description
Sustainability in Transportation	Examines the concept of transportation sustainability, environmental impacts, and debates surrounding sustainable transportation systems
Carbon Reduction Strategies	Explores approaches used to reduce transportation-related emissions, including technological innovation, green logistics, alternative fuels, and carbon management initiatives.
Challenges Faced by Businesses	Examines financial, technological, operational, organisational, and regulatory barriers affecting sustainability implementation.
Strategic Responses by Businesses	Investigates how transportation organisations respond to sustainability pressures through governance, innovation, collaboration, stakeholder engagement, and resilience-building strategies.

Source: Author's thematic analysis

3.9 Reliability, Validity, and Ethical Considerations

Ensuring the reliability, validity and ethical integrity of the research process was important to maintaining the credibility of this study. Although the research relied exclusively on secondary published literature, systematic procedures were applied throughout the identification, selection, analysis and interpretation of evidence to strengthen the trustworthiness of the findings.

Reliability concerns the consistency and transparency of the research process (Saunders et al., 2023). Within this systematic literature review, reliability was strengthened through the use of clearly defined search strings, multiple academic databases, predetermined inclusion and exclusion criteria and a structured screening process. The search and selection procedures were documented to provide an audit trail and enable the methodology to be understood and, where appropriate, replicated by other researchers. The use of Web of Science, Scopus and ProQuest also reduced dependence on a single source of academic literature.

Validity was addressed by maintaining close alignment between the research questions, study-selection criteria, data extraction and thematic analysis. Studies were included based on their relevance to transportation sustainability, carbon reduction, implementation challenges and strategic organisational responses. During analysis, findings were compared across studies rather than relying on individual sources, allowing areas of convergence, disagreement and contextual variation to be identified. Particular attention was given to the applicability of international evidence to the UK context rather than assuming that findings from different regulatory and transportation environments were directly transferable.

Researcher interpretation represents a potential source of bias within qualitative thematic analysis. To reduce this risk, themes were developed through repeated engagement with the selected literature and checked against the underlying evidence throughout coding and refinement. Contradictory findings were retained where relevant rather than excluded because they differed from dominant patterns. The predefined eligibility criteria and systematic search process further reduced the possibility of selectively including evidence that supported particular conclusions.

From an **ethical perspective**, the study did not involve primary data collection or direct participation by individuals. Consequently, issues such as participant recruitment, informed consent, anonymity and direct collection of confidential personal information were not applicable in the same manner as they would be in interview-, survey- or observation-based research. The study analysed information already available through published academic sources and did not collect personally identifiable or private data from research participants.

Nevertheless, secondary research carries important ethical responsibilities. Particular attention was therefore given to **academic integrity, accurate citation, faithful representation of authors' findings and avoidance of plagiarism or misrepresentation**. Sources were referenced using the required Harvard referencing conventions, and findings were interpreted within the context in which they were originally reported.

Care was also taken not to alter or selectively present evidence in ways that could materially distort the conclusions of the original studies.

Where the reviewed studies involved human participants, the present research relied on the ethical procedures reported by the original authors rather than accessing their underlying confidential participant data. Only published findings were analysed. This maintained separation between the present secondary analysis and any personal or confidential information collected during the original primary studies.

Generative artificial intelligence (AI) tools were used in a limited supporting capacity during the preparation of this study. Their use primarily assisted with structuring and refining written material, improving grammar and clarity, and strengthening the overall presentation of the research. AI tools were not used as a substitute for the researcher's academic judgement or as a source of evidence within the systematic literature review. The researcher retained responsibility for the selection and interpretation of literature, thematic analysis, verification of sources and the final content of the study.

Overall, reliability and validity were supported through transparent search and selection procedures, systematic thematic analysis, cross-study comparison and critical consideration of contextual differences. Ethical integrity was maintained through responsible use of published evidence, accurate attribution and transparent reporting of the research process. These measures strengthened the credibility of the review while recognising the methodological limitations associated with qualitative secondary research.

3.10 Chapter Summary

This chapter has outlined and justified the methodological approach adopted to examine sustainability and carbon footprint reduction within the UK transportation industry. The study adopted an **interpretivist philosophy and a predominantly inductive research approach**, consistent with its focus on interpreting sustainability challenges, organisational responses and reported outcomes across different transportation contexts.

A **qualitative secondary research design based on a Systematic Literature Review (SLR)** was adopted to provide a structured and transparent synthesis of the existing evidence. Relevant studies were identified through **Web of Science, Scopus and ProQuest** using defined search strings and eligibility criteria. The study-selection

process involved screening, full-text assessment and the application of inclusion and exclusion criteria to establish a focused evidence base for analysis.

The selected literature was analysed using **Braun and Clarke's (2006) six-phase thematic analysis**, resulting in four principal themes: Sustainability in Transportation, Carbon Reduction Strategies, Challenges Faced by Businesses, and Strategic Responses by Businesses. The analysis was aligned with the research objectives and supported by the conceptual framework developed in Chapter Two, while allowing themes to emerge predominantly from the reviewed evidence.

Finally, reliability, validity and ethical considerations were addressed through transparent search and screening procedures, systematic analysis, cross-study comparison and responsible use and attribution of published evidence. Collectively, these methodological procedures provide the foundation for the presentation and analysis of the study's findings in the following chapter.

CHAPTER 4: FINDINGS

4.1 Introduction

This chapter presents the findings of the Systematic Literature Review examining sustainability and carbon footprint reduction within the UK transportation industry. The findings are derived from the thematic analysis of the **16 unique studies included in the final review** and represent the key patterns and relationships identified across the evidence base. In accordance with the methodology outlined in Chapter Three, this chapter focuses primarily on presenting the findings, while their wider theoretical interpretation and critical evaluation are developed in Chapter Five.

The thematic analysis identified four principal themes: **Sustainability in Transportation; Carbon Reduction Strategies; Challenges Faced by Businesses; and Strategic Responses by Businesses**. Collectively, the findings indicate that transportation sustainability is shaped by interconnected environmental, economic, technological, organisational and regulatory factors. They further demonstrate that carbon reduction is not solely dependent on the availability of low-carbon technologies but also on the conditions affecting their implementation and the capacity of businesses to respond strategically.

The chapter is therefore organised according to the four themes. The first examines how sustainability is understood and experienced within transportation; the second presents

the carbon reduction strategies identified across the studies; the third examines the principal barriers affecting their implementation; and the fourth presents the strategic responses adopted by businesses in addressing these challenges. Together, these findings provide the evidence base for the subsequent discussion of the research objectives, conceptual framework and wider literature in Chapter Five.

4.2 Findings Related to Sustainability in Transportation

The thematic analysis identified sustainability as an increasingly significant issue within the transportation industry, extending beyond environmental concerns to influence organisational decision-making, regulatory compliance, operational performance and long-term business priorities. Across the reviewed studies, growing concern over greenhouse gas emissions, climate change, stakeholder expectations and national decarbonisation commitments emerged as important drivers of sustainability within transportation.

A recurring finding was the **multidimensional nature of transportation sustainability**. Although environmental performance and carbon reduction featured prominently, the evidence also highlighted economic viability, operational efficiency and social considerations. Transportation businesses therefore operate within a context where environmental objectives must be balanced against commercial and operational requirements. Sustainability consequently involves the integration of environmental considerations into broader organisational and operational decision-making rather than their treatment as isolated initiatives.

The evidence also demonstrated the **interconnected nature of transportation systems**. Environmental outcomes were influenced not only by vehicle technologies but also by infrastructure, energy systems, logistics and supply-chain networks, regulatory conditions and stakeholder behaviour. Consequently, the effectiveness of sustainability initiatives frequently depended on factors beyond the direct control of individual businesses. This systems dimension was particularly relevant where the adoption of low-carbon technologies depended upon supporting infrastructure, energy availability or coordination between multiple actors.

External pressures emerged as another prominent influence on transportation sustainability. Regulatory requirements, government climate policies, customer expectations, investor concerns and wider societal demands were repeatedly identified as factors influencing organisational sustainability priorities. Businesses were therefore found to respond to sustainability pressures for several reasons, including regulatory compliance, environmental responsibility, corporate reputation and competitive

considerations. However, the extent to which these pressures translated into substantive organisational action varied across the reviewed evidence.

The analysis revealed considerable **variation in sustainability implementation between organisations**. While some businesses integrated sustainability into strategic planning and operational decision-making, others adopted more fragmented or reactive approaches. Differences in organisational resources, leadership commitment, technological capability, sustainability expertise and operating conditions were associated with variation in implementation. This indicates that recognition of sustainability pressures does not necessarily result in equivalent organisational responses or outcomes across transportation businesses.

The findings further showed that transportation sustainability is closely connected to wider **decarbonisation and net-zero agendas**, particularly within the UK and other jurisdictions pursuing significant emissions reductions. Nevertheless, sustainability was not confined to carbon reduction alone. Resource efficiency, environmental stewardship, stakeholder engagement and organisational resilience also appeared within the reviewed evidence, demonstrating the broader scope of sustainability within transportation.

Overall, the findings identify transportation sustainability as a **multidimensional and interconnected business issue** shaped by environmental pressures, stakeholder expectations, organisational conditions and wider transportation systems. The evidence indicates that businesses operate within different resource, technological and institutional circumstances, resulting in variation in how sustainability priorities are translated into practice. These findings provide the context for the carbon reduction strategies identified in the following section.

4.3 Findings Related to Carbon Reduction Strategies

The thematic analysis identified a range of carbon reduction strategies being pursued across the transportation industry. These strategies varied according to transport mode, technological maturity, infrastructure availability and organisational context. The most prominent approaches involved **vehicle electrification, alternative fuels, operational efficiency, green logistics and digital technologies**, indicating that transportation decarbonisation is being pursued through a combination of technological and operational interventions.

Vehicle electrification emerged as one of the most frequently identified strategies, particularly within road transportation and urban mobility. The transition from internal

combustion engine vehicles to battery-electric alternatives was associated with the potential to reduce direct operational emissions substantially. However, the evidence also indicated that the feasibility and environmental performance of electrification depend on factors including charging infrastructure, electricity generation, vehicle range, operational requirements and fleet characteristics. Electrification therefore appeared more readily applicable in some transportation contexts than others.

Alternative fuels and energy sources represented another important pathway. The reviewed evidence identified hydrogen, biofuels and other lower-carbon energy options as potential alternatives where full electrification may be technically or operationally difficult. Their suitability varied between transport applications, particularly where vehicle range, payload, refuelling requirements and infrastructure availability influenced technology selection. The findings therefore indicated that no single energy technology currently provides a universally applicable solution across the transportation industry.

A further group of strategies focused on **operational efficiency and logistics optimisation**. Route optimisation, improved vehicle utilisation, reduced empty running, efficient scheduling and fleet-management practices were identified as mechanisms through which businesses could reduce fuel consumption and associated emissions. Unlike some capital-intensive technological transitions, these measures could potentially generate both environmental and operational benefits by reducing unnecessary mileage and improving resource utilisation.

Green logistics and supply-chain practices also featured within the evidence. These included improved freight consolidation, modal choices, more efficient distribution arrangements and greater consideration of environmental performance within logistics decisions. The findings suggested that carbon reduction opportunities extend beyond individual vehicles and include how transportation activities are planned and coordinated across wider logistics and supply-chain systems.

The reviewed studies further identified **digitalisation and data-driven transport management** as supporting carbon reduction. Digital fleet-management systems, emissions monitoring, telematics and data analytics can assist organisations in identifying inefficiencies, monitoring environmental performance and improving operational decision-making. However, their contribution to emissions reduction depends on how effectively the information generated is translated into operational action.

Across these strategies, the evidence indicated that transportation decarbonisation is unlikely to depend on a **single intervention**. Different technologies and operational measures address different sources of emissions and face different implementation conditions. Consequently, combinations of technological transition, operational efficiency and improved logistics practices were evident across the reviewed literature.

Overall, the findings demonstrate that businesses have access to multiple pathways for reducing transportation-related carbon emissions, but the suitability of individual strategies varies considerably across organisational and transportation contexts. Their implementation is influenced by financial, technological, infrastructural and operational conditions, which form the focus of the following section.

4.4 Findings Related to Challenges Faced by Businesses

The thematic analysis identified several interrelated challenges affecting businesses' ability to implement sustainability and carbon reduction initiatives. The most prominent were **financial constraints, technological uncertainty, infrastructure limitations, regulatory complexity, organisational capability and operational requirements**. Rather than occurring independently, these barriers frequently interacted, increasing the complexity of sustainability implementation across transportation businesses.

Financial constraints emerged as a significant barrier, particularly where decarbonisation required substantial upfront investment in low-carbon vehicles, alternative-fuel technologies, charging or refuelling infrastructure and supporting systems. Although some investments may generate longer-term savings through improved efficiency and reduced fuel consumption, uncertainty regarding payback periods and future operating costs can complicate investment decisions. These challenges may be particularly significant where businesses have limited access to capital or competing operational priorities.

Technological challenges were also evident across the reviewed studies. Concerns relating to technology maturity, vehicle range, reliability, payload requirements and compatibility with existing operations influenced the feasibility of low-carbon alternatives. The findings indicated that technologies suitable for particular transport activities may be less appropriate for others, especially where businesses operate long-distance, energy-intensive or operationally demanding services. This technological variation contributes to uncertainty regarding the timing and scale of investment.

Closely related to technological barriers were **infrastructure limitations**. The availability and capacity of charging networks, alternative-fuel refuelling facilities and supporting energy infrastructure were identified as important conditions affecting adoption. Businesses may therefore be willing to introduce lower-carbon technologies but remain constrained where the external infrastructure required to support reliable operations is insufficient. This demonstrates that implementation is partly dependent on developments beyond the direct control of individual organisations.

The evidence further identified **regulatory and policy uncertainty** as an implementation challenge. Although environmental regulation and net-zero commitments can encourage businesses to pursue decarbonisation, changes in policy direction, incentives, standards and compliance expectations can also create uncertainty for long-term investment decisions. Transportation businesses must therefore make strategic commitments while technological and regulatory environments continue to evolve.

Organisational and capability-related barriers were also apparent. Differences in leadership commitment, sustainability expertise, organisational culture, technical knowledge and internal resources influenced the extent to which businesses could plan and implement sustainability initiatives. The findings indicated that access to technology alone does not guarantee successful implementation; organisations also require appropriate knowledge, managerial capability and internal commitment to integrate sustainability into existing operations.

Finally, businesses faced **operational challenges** associated with maintaining service reliability, cost competitiveness and customer requirements while introducing sustainability measures. Changes to vehicle technologies, routes, schedules or operating practices may affect established processes and therefore require businesses to balance carbon reduction objectives against commercial and service-delivery requirements.

A significant cross-cutting finding was that these challenges were **interconnected rather than isolated**. Financial decisions could be affected by technological uncertainty; technological adoption could depend on infrastructure availability; and organisational capability could influence how effectively businesses responded to regulatory or operational pressures. Consequently, the implementation of transportation sustainability initiatives involves managing combinations of barriers rather than resolving individual challenges independently.

Overall, the findings demonstrate that the availability of carbon reduction strategies does not necessarily translate into straightforward implementation. Businesses operate

within different financial, technological, infrastructural, regulatory and organisational conditions, which influence both the feasibility and pace of decarbonisation. The strategic responses adopted to manage these challenges are examined in the following section.

4.5 Findings Related to Strategic Responses by Businesses

The thematic analysis identified a range of strategic responses adopted by transportation businesses to manage sustainability pressures and the challenges associated with carbon reduction. The evidence indicated that organisations are not responding to these pressures solely through the adoption of low-carbon technologies. Instead, businesses employ combinations of **strategic integration and governance, investment and prioritisation, stakeholder collaboration, operational adaptation, and organisational learning and capability development**.

A prominent response involved the **integration of sustainability into organisational strategy and governance**. Across the reviewed evidence, sustainability objectives were increasingly incorporated into corporate planning, carbon management programmes, environmental performance indicators and internal monitoring arrangements. This represented a shift from treating sustainability primarily as a compliance or environmental function towards embedding carbon reduction considerations within wider organisational decision-making.

Strategic investment and prioritisation also emerged as an important response. Given the financial and technological uncertainties associated with decarbonisation, businesses were found to make choices regarding the timing, scale and combination of sustainability investments. Rather than pursuing all available interventions simultaneously, organisations adopted approaches reflecting their operational requirements, available resources and technological readiness. This included combining longer-term investments in low-carbon technologies with more immediate operational measures capable of improving efficiency and reducing emissions.

The findings further identified **collaboration and stakeholder engagement** as significant responses to implementation challenges. Transportation businesses engaged with suppliers, customers, government agencies, infrastructure providers and other organisations to access knowledge, coordinate activities and address constraints that could not be resolved independently. Collaboration was particularly relevant where sustainability initiatives depended on shared infrastructure, supply-chain coordination or technological expertise. This demonstrated that some barriers to transportation

decarbonisation require responses extending beyond individual organisational boundaries.

Operational adaptation represented another recurring response. Businesses implemented measures including route optimisation, logistics restructuring, fleet-efficiency programmes and changes to operating practices to improve environmental performance while maintaining service reliability. These measures allowed organisations to pursue incremental carbon reductions alongside longer-term technological transitions. The evidence therefore indicated that businesses frequently balance immediate operational improvements with more transformational sustainability initiatives.

The analysis also highlighted the importance of **organisational learning and capability development**. Transportation decarbonisation occurs within rapidly changing technological and regulatory environments, requiring businesses to monitor developments and adjust their approaches over time. Training, sustainability expertise, performance monitoring and continuous evaluation were identified as mechanisms through which organisations strengthened their capacity to implement and refine sustainability initiatives. The reviewed evidence therefore suggested that strategic responses evolve as organisations gain experience and as external conditions change.

A key cross-cutting finding was that strategic responses appeared most effective when implemented in an **integrated rather than isolated manner**. The evidence associated stronger sustainability outcomes with combinations of technological investment, governance arrangements, stakeholder collaboration, operational improvement and organisational learning. Conversely, fragmented approaches focused on individual interventions appeared less capable of addressing the interconnected financial, technological, infrastructural and organisational barriers identified in the preceding section. This integrated-response finding is already evident in the original analysis and is important to retain.

Overall, the findings demonstrate that transportation businesses respond to sustainability pressures through a combination of **strategic, organisational and operational measures**. The nature and extent of these responses vary according to organisational resources, capabilities and operating conditions. Nevertheless, the evidence indicates that progress towards carbon reduction is supported where businesses are able to combine appropriate technologies with governance, collaboration, operational adaptation and continuous organisational learning.

4.6 Chapter Summary

This chapter presented the findings derived from the thematic analysis of the **16 studies included in the systematic review**. Four principal themes emerged: Sustainability in Transportation, Carbon Reduction Strategies, Challenges Faced by Businesses, and Strategic Responses by Businesses. Collectively, the findings demonstrate that transportation decarbonisation is shaped by the interaction between environmental and stakeholder pressures, available carbon reduction strategies, implementation conditions and organisational responses.

The evidence identified electrification, alternative fuels, operational efficiency, green logistics and digitalisation as important carbon reduction pathways. However, their implementation was constrained by interconnected financial, technological, infrastructural, regulatory, organisational and operational challenges. In response, businesses adopted measures including sustainability governance, strategic investment, stakeholder collaboration, operational adaptation and capability development. Overall, the findings indicate that carbon reduction outcomes depend not simply on the availability of sustainability solutions, but on businesses' ability to combine appropriate interventions with the organisational capacity to manage implementation challenges. Chapter Five critically interprets these findings in relation to the research objectives, existing literature and the study's conceptual and theoretical framework.

CHAPTER 5: DISCUSSION

5.1 Introduction

This chapter critically discusses the findings of the Systematic Literature Review in relation to the research objectives, research questions, existing literature and the conceptual framework developed in Chapter Two. While Chapter Four presented the principal patterns emerging from the thematic analysis of the **16 included studies**, this chapter interprets their significance and examines how they contribute to understanding sustainability and carbon footprint reduction within the UK transportation industry.

The findings demonstrate that transportation decarbonisation involves more than the availability or adoption of low-carbon technologies. Businesses operate within a wider system of regulatory, stakeholder and environmental pressures that influence

sustainability priorities, while the implementation of carbon reduction strategies is affected by financial, technological, infrastructural, operational and organisational challenges. The evidence further indicates that businesses respond to these conditions through governance, investment, collaboration, operational adaptation and capability development, with the effectiveness of these responses varying according to organisational and contextual circumstances.

The discussion therefore examines the relationships between **external sustainability pressures, carbon reduction strategies, implementation challenges, strategic business responses and sustainability outcomes**. Particular attention is given to areas of agreement and disagreement within the literature and to the conditions that influence the effectiveness of different approaches. This enables the discussion to move beyond describing individual interventions towards explaining why sustainability outcomes vary between organisations and transportation contexts.

The findings are also interpreted through **Stakeholder Theory and the Resource-Based View (RBV)**. Stakeholder Theory provides a basis for examining how regulatory bodies, customers, investors, communities and other external actors influence organisational sustainability priorities, while RBV supports analysis of how differences in financial, technological, managerial and organisational resources affect businesses' capacity to respond. These perspectives are used together to interpret the interaction between external pressures and internal organisational capabilities rather than as competing explanations.

Through this analysis, the chapter evaluates how the findings address the research gap identified in Chapter Two: the limited integrated understanding of how transportation businesses navigate sustainability pressures and implementation challenges while developing strategic responses to carbon reduction. The discussion consequently provides the basis for identifying the study's academic and practical contributions in the concluding chapter.

5.2 Sustainability as a Strategic Business Imperative

A significant finding of this study is that sustainability has evolved beyond a predominantly environmental concern to become a **strategic business imperative** within the transportation industry. The reviewed evidence indicates that transportation organisations increasingly balance carbon reduction with operational efficiency, regulatory compliance, stakeholder expectations and long-term competitiveness. Sustainability therefore influences organisational strategy and decision-making rather than remaining confined to environmental management activities.

This finding supports the broader literature that conceptualizes transportation sustainability as multidimensional, incorporating environmental, economic and social considerations. Earlier research has demonstrated the importance of reducing transportation emissions and improving environmental performance (Brand et al., 2012), while more recent evidence places greater emphasis on the structural, organisational and behavioural conditions necessary to achieve meaningful decarbonisation. Recent European research, for example, indicates that substantial reductions in mobility-related emissions require changes extending beyond individual technological choices to wider political, economic and societal structures. This reinforces the finding that transportation sustainability cannot be addressed effectively through technological substitution alone.

The findings can be further interpreted through **Stakeholder Theory**, which proposes that organisational decisions are influenced by multiple actors whose expectations affect organisational priorities and legitimacy. Within transportation, regulatory bodies, customers, investors, communities and other stakeholders create pressures that can influence sustainability commitments. The evidence from this study indicates that such pressures increasingly affect how businesses define organisational performance: traditional measures such as cost, efficiency and service delivery now coexist with expectations concerning carbon emissions and environmental responsibility. This supports the view that sustainability can influence corporate legitimacy, reputation and competitive positioning.

However, stakeholder pressure does not necessarily produce uniform organisational responses. While regulation and customer or investor expectations may encourage sustainability action, businesses differ in the extent to which these pressures are translated into strategic priorities and operational change. This variation suggests that external pressure alone cannot fully explain sustainability performance. Organisations may face similar expectations but possess different financial resources, technological capabilities, managerial expertise and operational constraints. This finding provides an important connection between the stakeholder perspective and the Resource-Based View, which is examined more directly in relation to implementation challenges and strategic responses later in this chapter.

The findings also challenge approaches that frame transportation decarbonisation primarily as a **technological problem**. Low-carbon technologies remain essential, but their implementation depends on organisational decisions concerning investment, resource allocation, capability development and stakeholder coordination. The existing Chapter Four evidence similarly showed that sustainability outcomes are influenced by organisational and strategic factors rather than technology alone. This supports a

broader systems perspective in which technologies interact with infrastructure, regulation, operational practices and stakeholder behaviour.

This systems dimension is particularly important because individual transportation businesses do not exercise complete control over the conditions required for decarbonisation. Charging and refuelling infrastructure, energy systems, supply chains and policy frameworks involve multiple actors. Consequently, businesses may possess strong sustainability intentions while remaining dependent on external systems and stakeholders for successful implementation. This creates an important tension between **organisational responsibility and systemic dependency**: businesses are central to translating sustainability objectives into action, yet their capacity to do so is partly shaped by conditions beyond their organisational boundaries.

This finding directly contributes to the research gap identified in Chapter Two. Existing transportation sustainability research provides substantial knowledge regarding emissions, technologies and policy pathways, but comparatively less integrated attention has been given to how businesses interpret these pressures and translate them into organisational action. The present findings indicate that transportation businesses occupy a critical intermediary position between wider sustainability expectations and practical implementation. They determine how resources are allocated, which carbon reduction initiatives are prioritised and how environmental objectives are integrated with commercial and operational requirements.

Overall, sustainability can therefore be understood as a strategic business imperative because it increasingly influences **organisational legitimacy, decision-making, competitiveness and long-term resilience**. Nevertheless, recognising sustainability as strategically important does not itself guarantee effective carbon reduction. The critical issue is how businesses convert sustainability pressures into appropriate interventions under differing organisational and external conditions. This provides the basis for examining the integration of carbon reduction strategies in the following section.

5.3 Carbon Reduction Requires Integrated Rather than Isolated Strategies

A central finding of this study is that effective carbon footprint reduction within transportation is unlikely to result from a single intervention. Although electrification, alternative fuels, operational efficiency, green logistics and digital technologies all offer opportunities for emissions reduction, their effectiveness depends on the conditions within which they are implemented. This supports the view that transportation

decarbonisation requires an **integrated portfolio of technological and operational strategies** rather than reliance on a universally applicable solution.

Electrification illustrates this complexity. Battery-electric vehicles offer significant potential for reducing direct operational emissions, particularly within road transportation. However, their effectiveness is influenced by charging infrastructure, electricity supply, vehicle range, payload requirements and operational patterns. Within UK road freight specifically, systems analysis of electrification and hydrogen similarly demonstrates that technology choices must be considered alongside the supporting energy and infrastructure systems required for their deployment (Haugen et al., 2022). Consequently, the environmental potential of a technology should be distinguished from its practical feasibility within particular transportation contexts.

Alternative fuels, including hydrogen and biofuels, provide additional pathways where complete electrification may be less suitable. However, these alternatives also involve trade-offs concerning cost, infrastructure, energy availability and technological maturity. Neagoe et al. (2024), for example, demonstrate that the transition towards alternative-fuel road logistics involves interconnected socio-technical, economic and environmental challenges rather than a straightforward replacement of fossil-fuel vehicles. This reinforces the finding that technological diversity may be necessary because transportation activities differ substantially in their operational and energy requirements.

Importantly, the findings indicate that technological transition should be complemented by **operational carbon reduction measures**. Route optimisation, improved vehicle utilisation, fleet management, logistics efficiency and digital monitoring can reduce unnecessary mileage and energy consumption while potentially generating operational benefits. Existing systematic evidence similarly identifies a broad range of green transportation and carbon-emission-reduction practices rather than a single dominant intervention (Bilek et al., 2024). This suggests that businesses should evaluate combinations of measures according to their specific operational characteristics rather than simply adopting technologies because of their theoretical emissions-reduction potential.

The findings therefore reveal an important distinction between **technical potential and organisational implementation**. A carbon reduction strategy may be technically capable of reducing emissions but deliver limited practical benefit where infrastructure, finance, operational compatibility or organisational capability is inadequate. Conversely, incremental operational improvements may produce more immediate reductions while organisations prepare for longer-term technological transitions.

Carbon reduction can therefore be understood as a staged and adaptive process in which short-, medium- and long-term interventions are combined according to organisational circumstances.

This interpretation also develops the conceptual framework presented in Chapter Two. Carbon reduction strategies represent the mechanisms through which businesses attempt to translate sustainability pressures into environmental improvements; however, the pathway from strategy adoption to carbon reduction outcomes is not direct. **Implementation challenges intervene between intention and outcome**, meaning that the effectiveness of a strategy depends partly on how successfully those barriers are managed. Recent evidence on road-freight electrification similarly identifies technological, financial, institutional and socio-cultural barriers and emphasises organisational responses such as planning, system differentiation and collaboration.

Overall, the findings support an **integrated and context-sensitive approach to transportation decarbonisation**. Electrification, alternative fuels, operational optimisation, green logistics and digitalisation should not be regarded as competing universal solutions but as complementary options whose relevance varies across transportation activities. The critical issue for businesses is therefore not simply which carbon reduction strategies exist, but **which combination is feasible within their operational context and how implementation barriers can be managed**. These barriers and their interactions are examined in the following section.

5.4 Interconnected Challenges Shape Sustainability Outcomes

A major finding of this study is that the challenges affecting transportation decarbonisation are **interconnected rather than independent**. Financial constraints, technological uncertainty, infrastructure limitations, regulatory complexity, organisational capability and operational requirements frequently reinforce one another. This suggests that implementation difficulties cannot be adequately understood by examining individual barriers in isolation.

Financial constraints provide a clear example of this interaction. Low-carbon vehicles and supporting infrastructure can require substantial initial investment, but investment decisions are also influenced by uncertainty surrounding technological maturity, infrastructure availability and future regulatory requirements. Businesses may therefore hesitate to commit significant resources where the long-term performance or supporting conditions of a technology remain uncertain. Evidence from UK zero-emission bus transitions similarly identifies interactions between high costs,

technological uncertainty, infrastructure requirements and organisational capacity, with smaller operators particularly constrained by limited financial and technical resources.

Infrastructure represents another important source of interdependence. The effectiveness of vehicle electrification or alternative fuels depends partly on charging, refuelling and energy systems that individual transportation businesses may not control. This creates a potential mismatch between organisational willingness to decarbonise and the external conditions required for implementation. Research comparing electric-bus implementation in England and Sweden, for example, found that investment costs and technological concerns interacted with regulatory support, route characteristics and institutional collaboration, demonstrating the context-dependent nature of implementation barriers.

The findings also demonstrate that **regulation can function simultaneously as a driver and a source of uncertainty**. Policy commitments and environmental standards create incentives for businesses to pursue decarbonisation, yet changing incentives, funding arrangements or regulatory expectations can complicate long-term investment decisions. UK road-freight research similarly demonstrates that the barriers to decarbonisation extend beyond techno-economic considerations to political and socio-technical factors, reinforcing the need to understand transition challenges within their wider institutional context.

The **Resource-Based View (RBV)** provides an important explanation for why these challenges do not affect all businesses equally. Organisations differ in their financial resources, technical expertise, managerial capability, knowledge and ability to adapt existing operations. Businesses possessing stronger resources and capabilities may therefore be better positioned to absorb investment costs, evaluate emerging technologies and manage operational change. Conversely, organisations with more limited resources may experience the same external barriers more severely. This suggests that implementation outcomes depend not only on the existence of barriers but also on the **organisational capacity to respond to them**.

This interpretation also highlights an important limitation of approaches that assume transportation businesses constitute a homogeneous group. Large organisations may possess greater investment capacity and specialist sustainability expertise, whereas smaller operators may face proportionately greater financial and capability constraints. Similarly, the feasibility of particular interventions varies according to transport mode, fleet characteristics, routes and operating requirements. Consequently, a strategy that is viable for one organisation cannot automatically be assumed to be equally feasible for another.

Viewed alongside Stakeholder Theory, the findings reveal an important interaction between **external pressure and internal capability**. Stakeholders may increase expectations for decarbonisation, but businesses require sufficient resources and capabilities to translate those expectations into effective action. External pressure without adequate organisational capacity may therefore produce compliance difficulties or delayed implementation, while strong internal capabilities without appropriate infrastructure or policy support may also be insufficient. This interaction strengthens the argument that transportation sustainability should be understood as both an organisational and a systems challenge.

Overall, the findings demonstrate that implementation barriers form an **interdependent system of financial, technological, infrastructural, regulatory, operational and organisational constraints**. Their significance varies according to business characteristics and operating context, making uniform approaches to transportation decarbonisation unlikely to be equally effective across the sector. The critical issue is therefore not simply identifying barriers, but understanding how businesses develop strategic responses capable of managing their interaction. This forms the focus of the following section.

5.5 Strategic Business Responses to Sustainability Challenges

The findings demonstrate that transportation businesses respond to sustainability challenges through a combination of **strategic, organisational and collaborative actions**, rather than through technological adoption alone. Governance integration, investment prioritisation, stakeholder collaboration, operational adaptation and capability development emerged as important mechanisms through which businesses manage the barriers associated with carbon reduction. This finding strengthens the argument that transportation decarbonisation is fundamentally an organisational transition as well as a technological one.

A particularly important response is the **integration of sustainability into organisational strategy and governance**. Businesses that incorporate environmental objectives into strategic planning, performance monitoring and investment decisions are better positioned to coordinate sustainability initiatives across different organisational functions. This contrasts with more fragmented approaches in which carbon reduction is treated primarily as a compliance requirement or isolated environmental activity. Strategic integration therefore provides a mechanism for connecting sustainability objectives with wider commercial and operational priorities.

The findings also demonstrate the importance of **strategic prioritisation and adaptation**. Businesses operate with finite financial and organisational resources and cannot necessarily implement every available carbon reduction measure simultaneously. Organisations therefore make choices regarding which technologies to adopt, when investments should occur and which operational improvements can deliver more immediate benefits. This supports the finding in Section 5.3 that transportation decarbonisation is better understood as an adaptive process involving combinations of short-, medium- and long-term interventions rather than a single technological transition.

Collaboration and stakeholder engagement are particularly significant where implementation depends on resources or infrastructure beyond the control of individual businesses. Cooperation with government, infrastructure providers, suppliers, customers and other industry actors can support knowledge exchange, investment coordination and the development of shared solutions. Recent UK research on urban freight similarly identifies stakeholder engagement as central to developing viable decarbonisation pathways because technological change frequently requires accompanying behavioural and organisational change. This reinforces the Stakeholder Theory perspective developed in this study: stakeholders are not simply sources of external pressure but can also become important participants in developing and implementing sustainability solutions.

The **Resource-Based View** provides further insight into the importance of organisational capability. Businesses differ in their access to finance, technical knowledge, sustainability expertise, managerial competence and capacity for organisational learning. These resources influence whether an organisation can evaluate emerging technologies, manage investment risk, adapt operations and respond effectively to changing sustainability expectations. Capability development therefore becomes a strategic response in itself rather than merely a supporting activity. Evidence from transport-transition research similarly emphasises the importance of organisational learning, collaboration and capability development in enabling transformational change.

However, the findings also suggest that internal organisational capability has limits. Even a well-resourced business may struggle to implement low-carbon technologies where charging infrastructure, energy supply, regulatory certainty or industry coordination is inadequate. Conversely, supportive policy and infrastructure may generate limited progress where organisations lack the resources or capabilities required to take advantage of them. Effective decarbonisation therefore depends on an

interaction between **internal organisational capability and external enabling conditions**.

This interaction helps integrate Stakeholder Theory and RBV within the conceptual framework. Stakeholder Theory explains how external actors create sustainability expectations and influence organisational priorities, whereas RBV helps explain why businesses differ in their capacity to respond to those expectations. The findings extend this relationship by indicating that businesses can also use collaboration and stakeholder engagement to obtain or complement resources they do not possess internally. Strategic responses therefore involve both the mobilisation of internal capabilities and engagement with external actors.

Overall, the findings indicate that effective business responses to transportation sustainability require more than selecting an appropriate carbon reduction technology. Organisations must develop the governance, resources, capabilities and external relationships necessary to implement and sustain their chosen strategies. This provides a more integrated explanation of transportation decarbonisation in which **external pressures, internal capabilities and collaborative action collectively influence sustainability outcomes**.

5.6 Discussion of the Conceptual Framework

The findings provide broad support for the conceptual framework developed in Chapter Two, while also demonstrating that the relationships between **sustainability pressures, carbon reduction strategies, implementation challenges, strategic business responses and sustainability outcomes** are more interconnected than a simple linear process might suggest.

The first component of the framework proposes that **external sustainability pressures** influence organisational action. The findings support this relationship, with regulatory requirements, climate commitments, customer expectations, investor concerns and wider societal pressures emerging as important drivers of transportation sustainability. Viewed through **Stakeholder Theory**, these pressures help explain why businesses increasingly incorporate sustainability into strategic and operational decision-making. However, the findings also indicate that exposure to stakeholder pressure does not necessarily result in equivalent responses across organisations.

The framework further proposes that businesses translate these pressures into **carbon reduction strategies**, including electrification, alternative fuels, operational efficiency, green logistics and digitalisation. However, the findings demonstrate that the pathway

between strategy adoption and sustainability outcomes is shaped by significant **implementation challenges**. Financial constraints, technological uncertainty, infrastructure limitations, regulatory complexity and operational requirements can restrict the feasibility or effectiveness of otherwise promising interventions.

The **Resource-Based View (RBV)** helps explain why businesses experiencing similar pressures and challenges may achieve different outcomes. Organisations differ in their financial resources, technical expertise, managerial capability, sustainability knowledge and capacity for organisational learning. These resources and capabilities influence how effectively businesses can manage implementation challenges and formulate strategic responses. RBV therefore operates within the framework as an important explanatory influence on the relationship between challenges and organisational responses rather than as a separate sequential stage.

The findings also support the importance of **strategic business responses** in determining sustainability outcomes. Governance integration, investment prioritisation, stakeholder collaboration, operational adaptation and capability development enable businesses to manage implementation barriers and improve the feasibility of carbon reduction initiatives. Importantly, stakeholder relationships can operate both as sources of external pressure and as mechanisms through which businesses access knowledge, infrastructure and collaborative support.

Overall, the revised framework suggests that transportation decarbonisation is best understood as a **dynamic interaction between external pressures, available carbon reduction strategies, implementation conditions and organisational capabilities**. Carbon reduction outcomes are therefore unlikely to depend solely on the technical potential of individual interventions. Instead, they are shaped by how effectively businesses mobilise internal resources, engage external stakeholders and adapt their strategies to changing operational and institutional conditions. This integrated perspective addresses the research gap identified in Chapter Two by connecting previously fragmented technological, organisational and implementation dimensions of transportation sustainability.

5.7 Implications for the UK Transportation Industry

The findings of this study have important implications for both theory and practice within transportation sustainability and carbon footprint reduction. By examining the relationships between sustainability pressures, carbon reduction strategies, implementation challenges and strategic business responses, the study provides an integrated perspective on how transportation businesses navigate the transition

towards lower-carbon operations. The implications extend beyond identifying available technologies by demonstrating the importance of organisational capabilities, stakeholder relationships and implementation conditions in determining sustainability outcomes.

5.7.1 Theoretical Implications

From a theoretical perspective, the study contributes to transportation sustainability literature by reinforcing the importance of **organisational and strategic factors** alongside technological and policy considerations. Although technological innovation remains fundamental to transportation decarbonisation, the findings demonstrate that its effectiveness is influenced by organisational resources, governance arrangements, stakeholder relationships and the capacity of businesses to adapt to implementation challenges. This supports a broader conceptualisation of transportation decarbonisation as an organisational and strategic transition rather than solely a technological process.

The combined application of **Stakeholder Theory and the Resource-Based View (RBV)** provides an additional theoretical contribution. Stakeholder Theory helps explain how regulatory bodies, customers, investors, communities and other external actors influence organisational sustainability priorities, while RBV explains how differences in financial, technological, managerial and knowledge-based resources affect businesses' capacity to respond. Considered together, the theories demonstrate that sustainability outcomes are shaped by the interaction between **external pressures and internal organisational capabilities**.

The study further contributes by demonstrating that implementation challenges should not be understood as isolated barriers. Financial, technological, infrastructural, regulatory, operational and organisational constraints interact and collectively influence the feasibility of carbon reduction initiatives. The conceptual framework therefore integrates sustainability pressures, carbon reduction strategies, implementation challenges, strategic responses and outcomes within a connected analytical structure. This helps address the fragmentation identified in the existing literature and provides a basis for future research examining how organisational characteristics influence sustainability implementation across different transportation contexts.

5.7.2 Practical Implications

The findings also provide practical implications for **transportation businesses, managers and policymakers within the UK**. For businesses, the evidence indicates that sustainability should be integrated into strategic planning, investment decisions and

operational management rather than treated as a standalone environmental activity. Carbon reduction strategies should also be selected according to organisational and operational circumstances, as no single technological solution is equally suitable across all transportation activities.

Transportation managers should therefore consider **integrated and phased approaches** that combine appropriate low-carbon technologies with operational efficiency, digitalisation and logistics improvements. Organisations should also strengthen the capabilities required to support implementation through sustainability expertise, leadership commitment, employee development, performance monitoring and organisational learning. This is particularly important where technological and regulatory conditions continue to evolve.

Collaboration is equally important because many implementation barriers extend beyond the control of individual businesses. Engagement with government, infrastructure providers, suppliers, customers and other industry stakeholders can facilitate knowledge sharing, infrastructure development and coordinated investment. For policymakers, the findings highlight the importance of **consistent policy direction, investment certainty and accessible supporting infrastructure**, particularly where businesses are expected to make substantial long-term commitments to emerging technologies.

Overall, the practical implication is that successful transportation decarbonisation requires alignment between **technology, organisational capability and the wider enabling environment**. Businesses require strategies and capabilities appropriate to their operating circumstances, while policymakers and industry stakeholders must support the infrastructure and institutional conditions necessary for those strategies to succeed.

5.8 Chapter Summary

This chapter critically discussed the findings in relation to the research objectives, existing literature and the study's conceptual framework. The analysis demonstrated that transportation sustainability is a strategic and organisational challenge requiring **integrated carbon reduction strategies** rather than reliance on isolated technological interventions.

The discussion further established that financial, technological, infrastructural, regulatory, operational and organisational challenges interact to influence implementation. **Stakeholder Theory and RBV** helped explain how external

sustainability pressures and internal organisational capabilities shape business responses and outcomes. Overall, the findings indicate that effective decarbonisation depends on the alignment of appropriate carbon reduction strategies, organisational capabilities, stakeholder collaboration and supportive external conditions.

The chapter also identified important theoretical and practical implications, particularly the value of integrating external stakeholder pressures with internal organisational capabilities when examining transportation sustainability. These findings provide the foundation for the conclusions, recommendations, contributions and limitations presented in Chapter Six.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter concludes the study on sustainability and carbon footprint reduction within the UK transportation industry. Drawing on the Systematic Literature Review and thematic analysis of the **16 studies included in the final review**, it consolidates the principal findings concerning sustainability pressures, carbon reduction strategies, implementation challenges and strategic business responses.

The chapter evaluates these findings in relation to the research aim, objectives and questions and considers their wider significance for transportation sustainability. Particular attention is given to the study's academic and practical contributions, including the insights provided by **Stakeholder Theory and the Resource-Based View (RBV)** in explaining the interaction between external sustainability pressures and organisational capabilities.

The chapter also acknowledges the limitations of the research and the measures taken to strengthen its credibility, before presenting recommendations for transportation businesses, industry stakeholders and policymakers. Finally, areas for future research are identified, followed by the overall concluding statement of the study.

6.2 Summary of Findings

The study identified four principal themes: **Sustainability in Transportation, Carbon Reduction Strategies, Challenges Faced by Businesses, and Strategic Responses by Businesses**. Together, these themes demonstrate that transportation decarbonisation is

shaped by the interaction between external sustainability pressures, available carbon reduction interventions, implementation conditions and organisational responses.

First, the findings established that **sustainability has become a strategic business concern** within transportation. Regulatory requirements, national decarbonisation commitments, stakeholder expectations and wider environmental pressures increasingly influence organisational priorities. Sustainability is therefore associated not only with environmental responsibility but also with operational performance, organisational reputation, competitiveness and long-term resilience.

Second, the study identified several **carbon reduction strategies**, including vehicle electrification, alternative fuels, operational efficiency, green logistics and digitalisation. However, no single intervention emerged as universally applicable. Their suitability and effectiveness vary according to transportation mode, infrastructure, operational requirements and organisational circumstances, supporting the need for integrated and context-sensitive approaches.

Third, implementation was affected by interconnected **financial, technological, infrastructural, regulatory, operational and organisational challenges**. These barriers frequently reinforce one another, meaning that the feasibility of carbon reduction strategies depends not simply on their technical potential but also on the conditions under which businesses attempt to implement them.

Finally, businesses were found to respond through **sustainability governance, strategic investment, stakeholder collaboration, operational adaptation and capability development**. The evidence suggests that organisations combining these responses may be better positioned to manage implementation challenges than those relying on isolated interventions. Differences in organisational resources and capabilities also help explain variation in how businesses respond to similar sustainability pressures.

Overall, the findings support the study's conceptual framework by demonstrating the relationship between **external sustainability pressures, carbon reduction strategies, implementation challenges, strategic business responses and sustainability outcomes**. They further indicate that transportation decarbonisation should be understood as both a technological and an organisational process.

6.3 Conclusions

This study concludes that achieving sustainability and meaningful carbon footprint reduction within the UK transportation industry requires more than the adoption of

low-carbon technologies. Although electrification, alternative fuels, digitalisation and operational efficiency remain important, their effectiveness depends on the organisational and external conditions within which they are implemented. Transportation decarbonisation should therefore be understood as both a **technological transition and a strategic organisational process**.

The study further concludes that sustainability pressures do not translate automatically into successful carbon reduction outcomes. Businesses must navigate interconnected financial, technological, infrastructural, regulatory and operational challenges, while differences in organisational resources and capabilities influence their ability to respond. Consequently, similar external sustainability pressures may produce different responses and outcomes across transportation organisations.

Effective decarbonisation therefore requires **integrated and adaptive business responses**. Sustainability governance, strategic investment, operational adaptation, stakeholder collaboration and capability development enable organisations to manage implementation barriers and translate carbon reduction ambitions into practical action. This reinforces the importance of aligning technological interventions with organisational capability and supportive external conditions.

The combined application of **Stakeholder Theory and the Resource-Based View** provides further explanation for these relationships. Stakeholder Theory demonstrates how external actors influence sustainability priorities, while RBV helps explain how differences in internal resources and capabilities affect organisational responses. Together, they support the conclusion that sustainability outcomes emerge from the interaction between **external pressures and internal organisational capacity**.

Overall, the study concludes that successful carbon footprint reduction within UK transportation depends not on any single strategy, technology or actor, but on the effective alignment of **carbon reduction interventions, organisational capabilities, stakeholder relationships and enabling infrastructure and policy conditions**. This integrated perspective provides a more comprehensive understanding of how transportation businesses can navigate the transition towards long-term sustainability.

6.4 Contributions of the Study

This study contributes to understanding sustainability and carbon footprint reduction within the UK transportation industry by synthesising previously fragmented technological, organisational and implementation perspectives. Its principal contribution lies in providing an integrated explanation of how sustainability pressures,

carbon reduction strategies, implementation challenges and strategic business responses interact to influence sustainability outcomes. The specific academic and practical contributions are outlined below.

6.4.1 Academic Contribution

The primary academic contribution is the development of an **integrated business-centred understanding of transportation decarbonisation**. While existing research provides extensive evidence concerning low-carbon technologies, emissions reduction and policy interventions, this study brings these perspectives together with the organisational conditions affecting their implementation. In doing so, it addresses the research gap concerning the limited integrated understanding of how transportation businesses navigate sustainability pressures while managing the challenges associated with carbon reduction.

A further contribution is the combined application of **Stakeholder Theory and the Resource-Based View (RBV)**. Their integration provides an explanatory connection between the external pressures influencing sustainability priorities and the internal resources and capabilities affecting organisational responses. This helps explain why businesses exposed to similar sustainability pressures and implementation challenges may respond differently and achieve different outcomes.

Finally, the study contributes through its conceptual framework, which connects **external sustainability pressures, carbon reduction strategies, implementation challenges, strategic business responses and sustainability outcomes**, while recognising the influence of organisational resources and capabilities. The framework provides a basis for examining transportation decarbonisation as an interconnected organisational process rather than a series of isolated technological or environmental interventions.

6.4.2 Practical Contributions

The principal practical contribution is a **decision-oriented perspective on transportation decarbonisation**. The study demonstrates that the suitability of carbon reduction interventions should be considered alongside organisational capability, implementation challenges and external enabling conditions rather than assessed solely on their technical emissions-reduction potential.

For transportation businesses and managers, this provides a structured basis for evaluating how sustainability ambitions can be translated into feasible organisational

action. For policymakers and industry stakeholders, it highlights the interdependence between business capability and external conditions such as infrastructure, regulation and stakeholder coordination.

Overall, the practical contribution lies in demonstrating that successful carbon reduction requires alignment between **appropriate interventions, organisational capability and the wider enabling environment**, providing a more integrated basis for sustainability decision-making within the UK transportation industry.

6.5 Limitations of the Study

Several limitations should be acknowledged when interpreting the findings of this study. Although measures were taken to strengthen methodological rigour, these limitations influence the scope and transferability of the conclusions.

First, the study relied exclusively on **secondary data through a Systematic Literature Review** and therefore did not capture the direct experiences of transportation managers, employees or other industry stakeholders. The findings are consequently dependent on the scope and quality of the available literature. This limitation was mitigated through a systematic search across **Web of Science, Scopus and ProQuest**, the application of predefined inclusion and exclusion criteria, and the structured selection and thematic analysis of relevant studies. Nevertheless, primary research could provide additional insight into contemporary organisational experiences.

Second, the transportation industry encompasses diverse subsectors with different technologies, operating conditions and decarbonisation requirements. Although the study adopts a broad transportation-industry perspective, the reviewed evidence was not evenly distributed across all transport modes, with stronger representation from road freight, logistics and road-based transportation contexts than from rail, aviation and maritime transport. Consequently, the findings should not be interpreted as representing each transportation subsector to the same extent. This limitation was managed by focusing the synthesis on cross-cutting sustainability challenges and strategic responses rather than assuming that individual findings or interventions are equally applicable across all transportation contexts..

Third, although the study focused on the **UK transportation industry**, some included studies provided international or broader geographical perspectives. Differences in regulatory frameworks, infrastructure, economic conditions and organisational practices may therefore affect the direct applicability of some evidence to the UK. This limitation was addressed by prioritising UK-relevant evidence where available and

interpreting international findings in relation to their relevance to the UK context rather than assuming direct transferability.

A further limitation concerns the **rapidly evolving nature of transportation decarbonisation**. Technologies, government policies, infrastructure and industry practices continue to develop, meaning that the evidence base may change as new research emerges. The review sought to reduce this limitation by incorporating recent literature, including studies published between **2022 and 2026**, alongside established earlier research necessary for theoretical and historical context. Nevertheless, the findings represent the evidence available within the study period and should be interpreted accordingly.

Finally, thematic analysis necessarily involves an element of **researcher interpretation**, particularly when synthesising findings across studies employing different methodologies and contexts. This creates the possibility of interpretive bias in coding and theme development. To mitigate this risk, the analysis followed a structured thematic process, maintained alignment with the research objectives and applied the four themes consistently across the selected literature. Transparent documentation of the search, selection and analytical procedures further strengthened the traceability of the findings.

Overall, these limitations do not invalidate the findings but define the boundaries within which they should be interpreted. The use of multiple academic databases, transparent selection criteria, systematic thematic analysis and recent evidence strengthened the credibility of the study, while the identified limitations provide clear directions for future research.

6.6 Recommendations

Based on the findings of this study, several recommendations are proposed to support sustainability and carbon footprint reduction within the UK transportation industry. These recommendations reflect the study's central finding that effective decarbonisation requires coordinated action involving organisational capability, appropriate carbon reduction interventions, stakeholder collaboration and supportive external conditions.

6.6.1 Recommendations for Transportation Businesses

Transportation businesses should adopt **integrated and context-specific sustainability strategies** rather than relying on isolated carbon reduction initiatives. Decisions concerning electrification, alternative fuels, digitalisation and operational

improvements should consider organisational resources, infrastructure availability, operational requirements and technological readiness.

Businesses should also embed sustainability within **corporate governance and operational decision-making**, supported by clear objectives, performance indicators and accountability mechanisms. This can strengthen alignment between environmental ambitions and wider commercial priorities.

Organisations should further invest in **capability development**, including sustainability expertise, leadership, employee training and organisational learning. Collaboration with suppliers, customers, infrastructure providers and industry partners should also be strengthened where implementation challenges extend beyond individual organisational boundaries.

6.6.2 Recommendations for Industry Stakeholders

Industry associations and professional bodies should facilitate **knowledge sharing and sector-wide collaboration** through sustainability guidance, benchmarking, good-practice frameworks and collaborative platforms. This can support businesses, particularly those with more limited internal sustainability expertise, in evaluating and implementing appropriate carbon reduction measures.

Greater coordination should also be encouraged across transportation networks and supply chains. Shared challenges relating to infrastructure, technology adoption and logistics efficiency are unlikely to be resolved effectively through isolated organisational action and may therefore benefit from coordinated industry responses.

6.6.3 Recommendations for Policy Makers

Policymakers should provide **consistent and long-term policy direction** capable of supporting business investment decisions. Greater regulatory certainty can reduce some of the risks associated with committing resources to emerging low-carbon technologies and infrastructure.

Continued investment in **enabling infrastructure**, including charging networks and alternative-fuel systems, is also necessary to support wider adoption of low-carbon transportation technologies. Policy interventions should recognise that technology adoption depends not only on organisational willingness but also on the availability and reliability of supporting systems.

Finally, policymakers should strengthen collaboration between government, transportation businesses, infrastructure providers and other industry stakeholders. Such coordination can help address systemic barriers and improve alignment between national decarbonisation objectives and the practical implementation conditions experienced by businesses.

6.7 Areas for Future Research

The findings and limitations of this study identify several opportunities for future research. First, future studies should incorporate **primary empirical research** involving transportation managers, sustainability professionals, policymakers and other industry stakeholders. Interviews, surveys or case studies could provide direct evidence of how businesses experience sustainability pressures, make carbon reduction decisions and manage implementation challenges, thereby complementing the secondary evidence synthesised in this study.

Second, further research should examine **specific transportation subsectors** such as road freight, public transport, rail, aviation and maritime transportation. The present study identified important cross-cutting patterns, but differences in technologies, infrastructure, operational requirements and regulatory conditions may influence sustainability implementation across individual subsectors.

Future research could also undertake **comparative studies across organisational and geographical contexts**. Comparisons between businesses of different sizes and resource capacities could provide greater insight into how organisational capabilities influence sustainability responses. Cross-country research could similarly examine how differences in policy, infrastructure and institutional conditions affect transportation decarbonisation.

Further investigation is also required into the **long-term effectiveness of emerging low-carbon technologies and digital solutions**, including electrification, hydrogen, alternative fuels and intelligent transportation systems. As these technologies mature, longitudinal research could evaluate their environmental, economic and operational performance under real-world conditions.

Finally, future research should empirically test and refine the **conceptual framework developed in this study**. Quantitative or mixed-methods research could examine the relationships between external sustainability pressures, carbon reduction strategies, implementation challenges, strategic business responses and sustainability outcomes. Attention could be given to whether **organisational resources and capabilities**

moderate the relationship between implementation challenges and strategic responses, thereby providing further empirical examination of the combined Stakeholder Theory and RBV perspective proposed in this research.

6.8 Final Concluding Statement

Sustainability and carbon footprint reduction represent significant strategic challenges for the UK transportation industry as businesses seek to reconcile environmental objectives with operational and commercial requirements. This study demonstrates that meaningful decarbonisation cannot be achieved through technological innovation alone. Rather, progress depends on how effectively businesses integrate appropriate carbon reduction strategies with organisational capabilities, stakeholder collaboration and supportive external conditions.

The study further demonstrates that sustainability pressures, implementation challenges and strategic business responses are interconnected. Through the combined perspectives of **Stakeholder Theory and the Resource-Based View**, the research highlights how external expectations influence sustainability priorities while internal resources and capabilities shape organisations' ability to translate those priorities into effective action.

Ultimately, the transition towards lower-carbon transportation requires **coordinated and adaptive action across businesses, policymakers and industry stakeholders**. By understanding transportation decarbonisation as both a technological and organisational process, businesses can be better positioned to manage implementation challenges and contribute to the UK's longer-term sustainability and carbon reduction objectives.

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