ASYMMETRIC AND SYMMETRIC RESPONSES OF THE ENVIRONMENTAL PERFORMANCE ON TOURISM INDUSTRY: A CASE STUDY OF D-8 COUNTRIES

A Thesis

Submitted to the Master's Study Program of Economics at the Faculty of Economics and Business in partial fulfillment of the requirements for the degree of

Master of Arts (M.A.)

Universitas Islam Internasional Indonesia

By:

Muhammad Khafidh

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UNIVERSITAS ISLAM INTERNASIONAL INDONESIA

DEPOK

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ABSTRACT

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This study explores the asymmetric and symmetric responses of the environmental performance on tourism industry in the context of D-8 countries. While the tourism sector significantly contributes to economic growth, its environmental impact, particularly in developing countries like those in the D-8 group, remains underexplored. Existing research often overlooks the nonlinear and complex relationships between environmental performance and tourism activities, creating a significant gap in literature. Addressing this gap, the study aims to analyze the short-run and long-run symmetric and asymmetric impacts of environmental performance on the tourism industry within D-8 countries using advanced econometric models such as ARDL and NARDL. Employing a quantitative approach, the research utilizes panel data from 2008 to 2024, sourced from reputable institutions like the World Data Bank, World Travel and Tourism Council (WTTC) and Yale Center for Environmental Law & Policy. By capturing both symmetric and asymmetric relationships, the study provides deeper insights into the dynamic interplay between environmental performance and tourism. The findings are expected to reveal the differential impacts of positive and negative shocks in environmental performance on tourism trends, offering actionable insights for policymakers. It is anticipated that the study will propose strategies for integrating green tourism practices, developing energy-efficient infrastructure, and adopting international environmental standards to foster sustainable tourism while mitigating ecological degradation in D-8 countries.

Keywords: *Asymmetric responses, Symmetric Responses, Environmental performance, Tourism industry, D-8 countries*.

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Muhammad Khafidh
August 11, 2025

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CHAPTER I
INTRODUCTION

This chapter discusses the framework context underlying this research study. It defines the research goals and relevant research questions, which are core components of the wide-ranging literature in relation to tourism. Lastly, the chapter discusses the expected theoretical contributions and practical benefits of this research study.

1.1 Background

Tourism is an important industry in the world economy, whose main purpose is to create economic growth, provide employment, and increase international knowledge through enhanced cultural exchanges. Tourism involves activities of visitors who travel to and stay for short periods, usually not greater than twelve months, in places different from their habitual setting, driven by McMunn et al.'s (2023) identified factors. The benefits accrued from tourism significantly benefit communities, government agencies, and locals; further, businesses that serve tourists and their employees are important players in community economies, deserving recognition from community leaders, policy makers, employees, and families as an important community and private-sector decision-making foundation (Wang et al., 2022). Tourism strengthens community economies through provision of employment and income generation through increased production and consumer spending related to tourism activity. The tourist multiplier concept refers to overall increases in output, earnings, and employment in an identified area that result from inter-industry linkages. The tourism economic effect is measured through a "multiplier" that directly affects tourist spending within a localized area (Islam et al., 2023).

Tourism is a swiftly growing industry and a significant element of the global economy. The significance of the tourism sector to the economy has increased in recent decades, as has the influx of international tourists. The World Travel and Tourism Council (2024) indicates that tourism activities constituted 10% of global GDP and generated one in ten employment (348 million) globally. The tourist sector has expanded into a substantial industry, resulting in more employment, enhanced family spending power, and elevated tax revenue for governments globally.

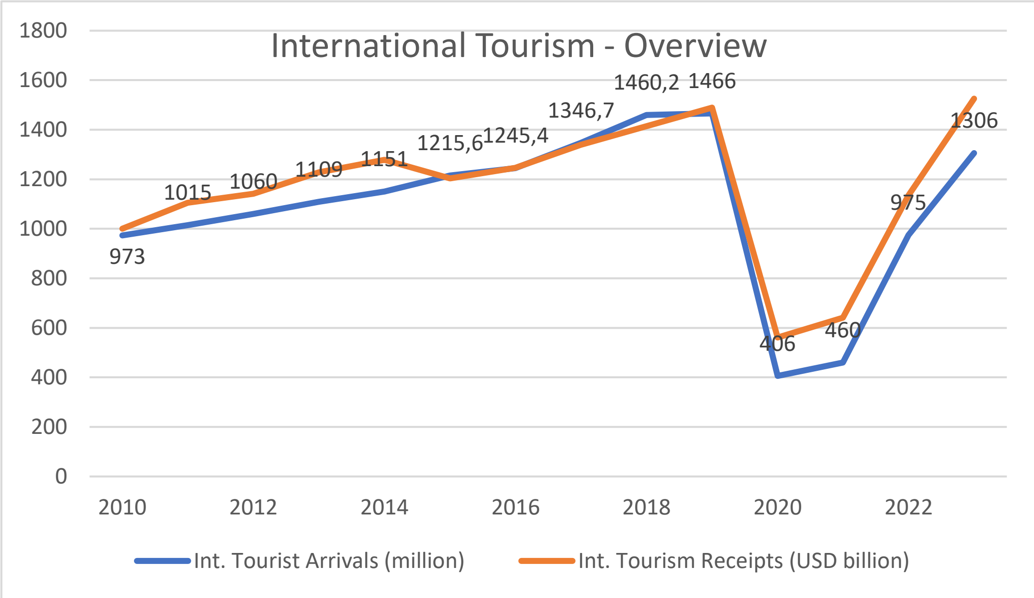


Figure 1.1 International Tourism Overview 2010-2024

Source: UNWTO 2024

The graph above provides an overview of international tourism trends over the period 2010 to 2024, which includes the number of international tourist arrivals (in millions) and receipts from international tourism (in billion USD). The data shows a consistent upward trend from 2010 to 2019, with the number of tourists increasing from 973 million to 1,460.2 million and tourism receipts peaking at USD 1,490 billion. However, there was a drastic drop in 2020 due to the COVID-19 pandemic, with arrivals falling to 406 million and receipts of only USD 561.1 billion. The trend began to recover in 2021 and 2022, although it has not yet returned to pre-pandemic levels. Tourism is an important sector for many countries due to its wide-ranging impact on the economy, society and the environment. Economically, tourism drives revenue through foreign exchange, creates jobs, and spurs infrastructure development. On the social side, tourism promotes cultural exchange, increases global awareness, and strengthens international diplomacy. Environmentally, tourism can support nature conservation through sustainable tourism. Therefore, this sector has a strategic role in supporting the country's development and post-pandemic economic recovery.

The COVID-19 pandemic did interrupt this growth, causing a dramatic collapse of international travel in 2020. However, the recovery since then has been strong. By late 2023 global tourism was back to roughly 90% of pre-pandemic levels. For example, an estimated 975 million international tourists traveled between January and September 2023 a 38% increase over the same period in 2022. Export revenues from international tourism in 2023 were expected to reach about US$1.4 trillion, or roughly 93% of the 2019 total. The World

Tourism Organization has projected that international arrivals could exceed 1.3 billion for the year, signaling a near-complete recovery of demand by 2024. In parallel, domestic tourism spending is also robust: WTTC (2024) reports that domestic visitor expenditure was about US$ 5.3 trillion globally in 2024, an increase of 5.4% from 2023. These data suggest that the global tourism system not only rebounded but is approaching or surpassing its previous peaks, demonstrating the sector's resilience and continuing importance (WTTC, 2024; UNWTO, 2023).

Nevertheless, this rapid expansion of tourism brings significant environmental and social challenges. The very activities that underpin tourism especially air travel, cruises, and high-volume mass tourism are energy-intensive and carbon-intensive. In fact, tourism's share of global greenhouse gas emissions has been steadily rising. Recent research estimates that in 2019 tourism generated about 5.2 $GtCO_2$-equivalent of emissions, representing roughly 8.8% of total human-induced GHG emissions that year. Tourism emissions grew at ~3.5% per year from 2009-2019, roughly twice the growth rate of the global economy. This means that the sector's average carbon intensity is higher than the world average and that continued tourism growth could jeopardize climate targets (Sun et al., 2024). Indeed, travel demand was projected to exceed 20 billion "person-trips" by 2024, which underscores the urgency of addressing tourism's environmental footprint.

Apart from carbon emissions, tourism exerts other environmental pressures. Popular destinations often suffer from overtourism, where too many visitors overwhelm natural resources and cultural sites. Examples include water scarcity in arid locales, waste and pollution from cruise ships, and degradation of fragile ecosystems. Tourism can strain infrastructure, drive up local prices, and generate congestion and waste problems that were highlighted even before COVID (Thullah & Jalloh, 2021; Baumann, 2021; Frent, 2016). In the post-pandemic era, tourists have become more aware of health, safety, and sustainability issues. Surveys indicate that many travelers now seek "green" experiences and are sensitive to a destination's pandemic preparedness and environmental practices (Yang, 2023; Noszczyk et al., 2021). At the same time, the pandemic altered patterns of travel behavior: there has been a shift toward domestic or regional travel for many, as well as increased interest in nature-based tourism and outdoor recreation. These trends create both challenges and opportunities for sustainable development. On one hand, the sector must manage a potential resurgence of mass tourism. On the other hand, it can leverage changing preferences to promote lower-impact tourism that benefits local communities and ecosystems (WTTC, 2024; UNWTO, 2023).

Table 1.1 Tourism Contribution to Economic Growth

Country	2024 GDP Contribution (%)	Annual Growth Rate (%)	Jobs in 2024 (Millions)	Jobs Added by 2034 (Millions)
Bangladesh	2.3%	7.2	2.18 (3.0%)	0.32
Egypt	8.1%	3.7	2.67 (9.1%)	1.3
Indonesia	5.1%	12.3	12.53 (9.0%)	4.66
Iran	5.2%	12.1	1.83 (7.5%)	0.36
Malaysia	10.5%	26.6	2.41 (14.6%)	1.09
Nigeria	3.9%	9.1	2.71 (3.8%)	2.61
Pakistan	6.1%	5.7	4.79 (6.7%)	1.7
Turkiye	12.4%	3.1	3.31 (10.5%)	0.43

Source: WTTC, 2024.

This table provides an overview of the economic contribution, growth rate, and employment dynamics in a particular sector in eight countries in 2024 and forecasting 2034. The sector's GDP contribution varies, with Turkiye having the highest percentage tourism contribution to GDP with 12.4%, followed by Malaysia with 10.5%. In contrast, Bangladesh has the lowest contribution of 2.3% to GDP. Annual growth rates also show significant differences, with Malaysia leading the way with the highest growth of 26.6%, reflecting the rapid recovery and development in the sector. On the other hand, Turkiye recorded a more moderate growth rate of 3.1%.

The number of jobs in the sector in 2024 also shows significant differences between countries. Indonesia has the largest number of jobs, reaching 12.53 million, while Iran has the lowest number, 1.83 million, despite its high GDP contribution. Projections to 2034 show that Indonesia will create 4.66 million new jobs, making it the country with the largest addition of jobs, while Bangladesh only adds 0.32 million jobs, which is the smallest number. Overall, this table shows that Malaysia and Indonesia stand out in terms of growth and job creation, while Bangladesh and Turkiye show slower development but still make positive contributions to the economy. This data reflects the importance of the sector as a driver of economic growth and job creation in the analysed countries.

While the global tourism industry grapples with these issues, the context in developing countries can be quite different. Developing economies often have both high tourism potential and high vulnerability. The Developing-8 (D-8) group including Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan, and Turkey illustrates this mix. These countries encompass diverse cultures and natural attractions, yet most are characterized by rapid population growth, emerging infrastructure, Islamic cultural and significant environmental risks. For instance, Bangladesh is one of the most climate-vulnerable countries in the world. Its deltas, beaches, and heritage sites face threats from cyclones, sea-level rise, and flooding (World Bank, 2022). In such settings, tourism development must contend not only with global issues like climate change but also with local challenges of sustainability and equity.

Economically, tourism's contribution varies widely across D-8 members. Some, like Malaysia and Turkey, have well-established tourism industries. Malaysia's travel sector accounted for about 8-10% of its GDP in recent years, while Turkey's tourism contributed roughly 12% of GDP by 2023. Egypt also depends heavily on tourism (around 8-9% of GDP) due to its archaeological and Red Sea resorts. In contrast, other D-8 economies currently see tourism as relatively small. For example, Nigeria's tourism sector contributed under 4% of GDP as of 2025, and Pakistan's tourism was roughly 5.9% of GDP in 2022. These figures understate the potential of tourism in those countries: Nigeria and Pakistan have rich cultural and natural assets (beaches, mountains, historical sites), but face obstacles like infrastructure gaps, security perceptions, and competition from better-known destinations. Notably, within the D-8, tourism activity tends to be uneven: one report found that Turkey and Malaysia together account for about three-quarters of D-8 tourism arrivals and receipts, underscoring the concentration of current growth in just a few members.

Environmentally, D-8 countries share some common pressures. Many lie in climates or geographies that are already stressed. Bangladesh's threats were noted; likewise, Pakistan is prone to water scarcity and glacier melt in its mountainous north (Ahmad et al., 2025; He et al., 2024). Indonesia and Malaysia face tropical deforestation and coral reef degradation under tourism development (Turisno et al., 2024; Naciri et al., 2023). Iran and Egypt must manage desertification and pollution in fragile ecosystems. Nigeria has mangrove deforestation and oil-related pollution in its coastal areas (Onyena & Sam, 2020; Aransiola et al., 2024). Even Turkey's tourism hotspots, such as the Mediterranean coast, are vulnerable to overuse of water resources and habitat loss (Cinar et al., 2024; Yılmaz at al., 2021). In addition, many D-8 destinations are culturally sensitive: mass tourism risks eroding traditional ways of life, raising social sustainability concerns. Thus, sustainable tourism development is particularly urgent in the D-8 context. Tourism must be planned to support economic growth without degrading the very resources it relies on (Baloch et al., 2022). For countries with limited regulatory capacity or where economic pressures to develop quickly are strong, achieving this balance is challenging.

Since the 20th century, tourism has evolved into a more prominent international industry owing to advancements in transportation, communication technology, and the gradual deregulation and separation of air travel from national airlines (Walton, 2018). The swift growth of tourism persistently plays a crucial role in the global economy.

Consequently, tourism has produced several economic benefits, including foreign exchange, tax revenue, job creation, international investment, and infrastructural advancement (Eyuboglu & Uzar, 2019)

Environmental performance significantly impacts the tourism industry in various ways, influencing both the financial performance of tourism firms and the overall attractiveness of destinations. Environmental factors and natural resources, such as wildlife, beautiful landscapes, and nature, often have a big impact on the tourism industry. Climate change and the long-term viability of the tourist industry have been looked at closely over the last two decades. In response, consumers and service providers (firms) have modified their behavior to appear and/or becomemore environmentally friendly (Shafiullah et al., 2023).

People are social beings, so they often change how they act based on their surroundings. This can be caused by belief, society, fashion, peer pressure, and virtue-signaling, among other things (Wallace et al., 2020). It is clear that both tourists and service providers (producers) who want to improve their social responsibility image behave in a way that fits the norm (Tan et al., 2017). Furthermore, shared human traits between nations, including culture, diaspora/immigration, ethnicity, faith, and official and unofficial languages, have been seen to increase and affect tourism between the two countries (Shafiullah et al., 2019).

The environmental performance and sustainability of the tourist and hospitality sector are facing heightened examination, with calls for increased sustainability within the sector (Bojanic & Warnick, 2020). Numerous enterprises within the sector have reacted by voluntarily implementing steps, frequently superficial, such as ecolabeling, to enhance sustainability and/or environmental performance. The environmentally conscious actions of tourism and hospitality service providers seek to enhance corporate sustainability and foster consumer brand loyalty (Tan et al., 2017).

The phenomenon of visible green behavior (i.e., green to be spotted) has often been noted in consumer behaviour, primarily outside the realm of tourism (Thøgersen & Olander, 2003). Consumers participate in "conspicuous conservation," such as operating hybrid automobiles and utilising eco-friendly items and grocery bags, as well as employing public transit and carpooling, to indicate charity or social status (Babutsidze and Chai, 2018). Consumers' adoption of environmentally friendly behaviours may be driven by charity, prestige, peer pressure, societal norms, or the need for virtue-signaling, among other factors (Brick et al., 2017). Specifically, Wei et al. (2018) and Rahman et al. (2020)

assert that customers are prepared to pay a premium to demonstrate their environmentally conscious behaviour.

The implementation of environmental sustainability initiatives in the tourist and hospitality sector is predominantly demand-driven, influenced by customer choices and shifts in tastes. Consumers are increasingly cognisant of the sustainability of tourism locations and are committed to the preservation of nature and the environment, as well as their image as international tourists (Bojanic, 2011; Gomes and Lopes, 2023). Consequently, we contend that international tourists alter their behaviour by selecting destinations based on environmental performance to project an eco-friendlier image (Josiassen and Assaf, 2013). By visiting an environmentally sustainable destination, or one comparable to their origin, tourists might exhibit conspicuous green behaviour intended for status enhancement and/or virtue signalling.

1.2 Problem Statement

The tourism sector is one of the most vital sectors of the global economy. Based on the World Travel & Tourism Council (WTTC) 2024 report, the contribution of the tourism sector to world GDP reaches around 10% and absorbs around 357 million jobs globally. This shows that tourism contributes significantly to national income, foreign exchange, and employment opportunities in various countries. The D-8 member countries (Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan, and Turkey) have great potential in the tourism sector due to their abundant natural and cultural wealth as well as the challenge of maintaining existing jobs or even increasing them. For example, Indonesia and Malaysia are known for their biodiversity and beautiful coral reefs (Rintelen et al., 2017); Egypt with its ancient historical heritage such as the Pyramids of Giza; and Turkey with its historical sites and medical tourism (Pirzada, 2022). Therefore, tourism development is one of the priorities to boost economic growth and improve people's welfare in the D-8 region.

On the other hand, D-8 countries also face serious environmental challenges. Climate change, pollution and ecosystem degradation pose real threats to the sustainability of natural tourism resources. For example, rising sea surface temperatures due to global warming can cause mass bleaching of coral reefs an important marine tourism asset as recorded in Indonesia (Gusviga et al., 2021). This damage to coral reefs has a direct impact on the decline of underwater beauty and a decrease in the number of diving tourists (Dimopoulos et al, 2025). In other words, environmental quality is a determining factor in the attractiveness of tourist destinations. Empirical research also confirms that environmental quality plays an important role in tourism performance. As an illustration, a European study found that improvements in environmental quality further supported tourism growth in countries with developed tourism industries (Keşanlı et al., 2025). Jannat et al. (2025) research in G7 country indicated that stronger economies and the adoption of green technologies make international tourism revenue increase, while increased pollution (CO_2) reduces tourism revenue and the same pattern is also seen in the short term and remains robust after trying other methods of checking. This indicates that regular checks on environmental performance (e.g. using environmental performance indices) are relevant for tourism policy planning.

Not to mention the ongoing phenomenon of visible green behavior (i.e., green to be spotted) that has been frequently noted in consumer behavior, especially outside the tourism field (Thøgersen & Olander, 2003). Consumers participate in "conspicuous conservation," such as operating hybrid cars and using eco-friendly goods and grocery bags, as well as using public transportation and carpooling, to demonstrate charity or social status (Babutsidze and Chai, 2018). Consumers' adoption of green behaviors may be driven by charity, prestige, peer pressure, societal norms, or the need for virtue signaling, among other factors (Brick et al., 2017). In particular, Wei et al. (2018) and Rahman et al. (2020) suggest that consumers are willing to pay a premium to demonstrate their environmentally conscious behavior.

Against this backdrop, it is important to better understand how environmental performance affects the tourism sector. Especially in D-8 countries that are rich in tourism potential but also vulnerable to environmental changes. The exact causal relationship (from environment to tourism) needs to be assessed as this will determine sustainable tourism management strategies.

Studies that examine the relationship between tourism and the environment have so far mostly highlighted the impact of tourism on environmental quality, such as pollution and ecosystem damage due to tourism activities. For example, Lee et al. (2021) used an autoregressive distributed lag (NARDL) model to analyze how tourism activities affect environmental performance in China and found that environmental damage due to increased tourist numbers is asymmetric. However, studies exploring the reverse direction of influence, i.e. how environmental performance impacts the growth and stability of the tourism sector are still very limited. This is especially true in the context of developing countries such as the D-8 members. The availability of studies that examine the response of the tourism sector to changes in environmental performance in both linear (symmetric) and non-linear (asymmetric) ways is almost nonexistent. In other words, there is not much literature that explicitly examines the response of the tourism industry to improving or deteriorating environmental conditions, let alone within the framework of asymmetric/symmetric analysis. The absence of such studies is a significant research gap, because without unidirectional research (environment-tourism) we do not have a picture of how much the role of environmental variables in encouraging or inhibiting the tourism sector in D-8 countries.

Understanding the relationship between environmental performance and the tourism sector is urgent to support sustainable tourism policies. International standards such as the Sustainable Development Goals (SDGs) have emphasized the importance of sustainable tourism development. SDG target 8.9 explicitly calls for countries by 2030 to develop and implement policies to promote sustainable tourism that creates jobs and promotes local cultures (United Nations, 2015). For D-8 countries, achieving these targets requires data-driven policies that integrate environmental aspects. Without adequate data on environmental performance, sustainable tourism policymaking can be poorly targeted. Deteriorating environmental conditions, such as global warming bleaching coral reefs or air pollution, can damage major tourist attractions and discourage tourists. Therefore, research that maps the impact of environmental performance on tourism growth is needed so that D-8 governments and stakeholders can design adaptive strategies, such as ecotourism development and conservation investments to mitigate environmental risks. By understanding the symmetric/asymmetric characteristics of this relationship, policymakers can prepare different scenarios in case environmental conditions change (e.g. drastically decline), so that the tourism industry remains resilient and sustainable.

1.3 Research Questions

Based on the background stated above, the research questions of this study can be formulated:

1. What are the short-run and long-run symmetric impacts of the environmental performance on tourism industry in D-8 countries?
2. What are the short-run and long-run asymmetric impacts of the environmental performance on tourism industry in D-8 countries?

1.4 Study Objectives

The main objectives of this study are to analyze the influence of the environmental performance on tourism industry in D-8 countries and recommend potential solutions to mitigate their impact. Specific objectives include:

1. To analyze short run and long run symmetric impact of environmental performance on tourism industry in D-8 countries.
2. To analyze short run and long run asymmetric impact of environmental performance on tourism industry in D-8 countries

1.5 Research Hypotheses

As per the previously mentioned research questions and research objective, the following hypotheses are the focus of this thesis:

1. H1: Tourism activities have both short-run and long-run positive symmetric impacts on environmental performance in D-8 countries.
2. H2: Tourism activities have both short-run and long-run positive asymmetric impacts on environmental performance in D-8 countries

Developing infrastructure and facilities is a top priority for government programs since they are very important for luring investors and tourists. For example, measures in West Pokot County, Kenya, that offer infrastructure and conveniences greatly improve the tourism performance (Patricia et al., 2019). In order to improve accessibility and appeal, India's tourist initiatives also involve infrastructural upgrades like fast-moving train connections (Mehrad et al., 2023).

Depending on the regulations supporting ecologically friendly practices, Chishti et al. (2020) show how tourism activities can favorably affect environmental performance in both the short and long terms. Key results show that, in the long run, rising tourism in Bangladesh, India, and Pakistan greatly lowers carbon dioxide emissions by 0.609%, 0.549%, and 0.174%, respectively, so highlighting the relative cleanliness of the tourism sector within the service industry against the industrial sectors. Moreover, by means of low-carbon infrastructure like green transportation and environmentally friendly lodging, tourism fosters innovation and energy economy. Governments should implement policies supporting international cooperation and renewable energy investments if they are to maximize these advantages. Research from Bojanic et al. (2020) says countries that depend on tourism tend to have lower GHG emissions and better environmental performance, especially if tourism makes up a significant part of their GDP.

Government policies are effective in improving the tourism industry while addressing environmental concerns. Government policies have a significant positive effect on sustainability dimensions related to the tourism industry, with tourism supply chain behavior acting as a meaningful mediator (Chiwaridzo, 2023). Similarly, in Italy, sustainable tourism policies are positively related to tourism demand and eco-labels play a role in the destination decision-making process (Serio et al., 2024).

1.6 Significance of Study

This study holds significant theoretical and practical value in understanding the relationship between environmental performance and the tourism industry, particularly in the context of D-8 countries. The key contributions of this study are outlined below:

1. Theoretical Contributions
    a. The research extends the literature on the interaction between environmental performance and tourism by examining both symmetric and asymmetric responses. This innovative approach provides a deeper understanding of how these variables influence one another in the short and long term.
    b. The research is the first to employing the Autoregressive Distributed Lag (ARDL) and Non-linear Autoregressive Distributed Lag (NARDL) model, this study introduces a rarely used method in the context of D-8 countries, offering novel insights into the dynamics of environmental and tourism performance.
    c. The findings contribute to academic discussions on sustainable tourism development, emphasizing empirical evidence for effective environmental and tourism policymaking.
2. Practical Contributions
    a. The study provides actionable insights for policymakers in D-8 countries to design tourism policies that integrate environmental sustainability, such as promoting green tourism practices and energy-efficient infrastructure.
    b. The results can guide the development of tourism promotion strategies that leverage environmental performance to attract eco-conscious international tourists.
    c. By highlighting the role of government policies in balancing tourism development and environmental preservation, the study offers a framework for sustainable tourism growth in resource-sensitive contexts.
3. Regional and Global Relevance
    a. This research delivers specific insights into the D-8 countries, which face unique challenges in balancing tourism growth with environmental conservation.
    b. The findings can serve as a reference for other developing countries dealing with similar issues, enabling the replication or adaptation of strategies for sustainable tourism and environmental management.

Through these contributions, the study not only enriches theoretical discourse on the interplay between tourism and environmental performance but also equips policymakers and industry practitioners with tools for promoting sustainable tourism practices.

1.7 Thesis Structure

There are five chapters in this thesis. The reader is given direction in understanding the issues that form the central point of this argument by Chapter I. This chapter is explained in a disciplined way, beginning with the problem's introduction, formulation, objectives, benefits of research, and writing strategy. The theoretical basis and conceptual framework, which are in alignment with the topics to be covered, are covered in Chapter II. A variety of sources, such as international journals, annual reports, or official reports retrieved from official institutions and government websites, are used to gather the theoretical foundation, also known as a literature study. Past research from foreign journals is presented next. The problem assumptions and the framework are presented at the end of this chapter. The problem analysis research approach is covered in Chapter III. Research methodologies, variable identification, types of data and sources, data collection procedures, and analysis techniques are all included in the research method. Chapter IV covers the fundamental definition of the research object, the variables used in the investigation, and the presentation of the research findings. Results include statistical tests, model analysis and hypothesis testing, estimation model selection, hypothesis validation, and a comprehensive description of the research findings. Chapter V covers the final portion of writing research results, along with recommendations for policy based on research findings and conclusions that address issues addressed.

CHAPTER II
LITERATURE REVIEW

This chapter is a starting point for this researcher. The bulk of this section is the literature review and theoretical framework. The literature review discusses how research on environmental performance and tourism. The researcher lays the foundation of the research; in this chapter the researcher focuses on the theoretical framework and literature review relevant to this research. The literature review is provided to elaborate on topics relevant to this research, so that a research gap can be found between the research that the researcher will do and the research that has been done.

Overall, this chapter will discuss environmental performance and tourism in the context of D8 Countries. whatt are the approaches, techniques and methods. so that later in the end it can be related to how especially D8 Countries directly manage their issue related to the environmental performance and tourism.

2.1 Theoretical Background

2.1.1 Tourism Industry

Goeldner & Ritchie (2011) defining Transportation, accommodation, restaurants, pubs, stores, entertainment, activity complexes, and other hospitality services all fall under the tourism industry, which is a combination of the numerous activities and services that yield a travel experience. It includes all service companies that deal with tourists and their needs. Travel, lodging, transportation, and everything else including advertising that caters to tourists' desires and requirements is collectively known as tourism. A nation, political entity, or transportation-centered economic area is defined as the total of all tourists spending within its borders. The income multiplier of these tourist expenditures is also taken into account by this economic notion.

We can say that the tourism sector encompasses a wide range of industries, including transportation, trade, accommodation, and all services needed by tourists during their travel activities. The continuous growth of the tourism sector is essential to maintaining a significant share of a countries or region’s economy, especially when the livelihoods of many depend on working in the tourism industry. This is because businesses within this sector are typically labor-intensive, such as hotels and companies providing travel services or tour agencies. Therefore, it is crucial to consistently maintain environmental performance to ensure the continued attraction of tourists.

Andika (2017) explains that tourism can bring about many benefits, including creating more job opportunities compared to other economic sectors. This is because the tourism industry is primarily service-oriented. The statement that the tourism industry is labor-intensive is indeed true and cannot be denied. The direct impact of tourism on employment opportunities is felt more significantly in developing countries compared to industrialized nations, as the scope of economic activities in developing countries is still relatively limited.

According to Nuzulia (2018), the tourism industry is a sector that heavily relies on human labor, not solely on machines or technology. Several businesses within the tourism industry influence employment absorption, including hotels, restaurants, travel agencies, tourist attractions, and souvenir shops. Tourists' spending on shopping and other activities can stimulate the growth of other economic sectors.

Tourists who purchase local souvenirs create job opportunities for local communities to produce these regional specialties. The hospitality industry requires a variety of goods, such as food supplies, decorative items, and other necessities to support hotel operations. This stimulates the growth of businesses in agriculture, livestock, decoration rentals or sales, light industries, and other sectors.

2.1.2 Environmental Performance

2.1.2.1. Environmental Performance Indes (EPI) Yale University

The Environment Performance Index (EPI) is a highly reliable indicator of sustainable development. It covers two aspects of sustainable development which is environmental health and ecosystem vitality. The EPI report (2024) uses 58 indicators across 11 categories for estimation purposes. The EPI was initially introduced in 2000 as the ESI. The environmental sustainability index (ESI) was originally created by scholars of Columbia and Yale universities, in collaboration with the World Economic Forum and the European Commission's Joint Research Centre, to address growing environmental concerns and their potential for effective management in the future. In 2006, ESI underwent a name change and became known as EPI. The most recent edition of the EPI is for the year 2024. The EPI framework's construction methodologies and underlying theory are thoroughly examined, along with its possible applications, as depicted in Figure (See Figure 2.1) (EPI Report, 2024).

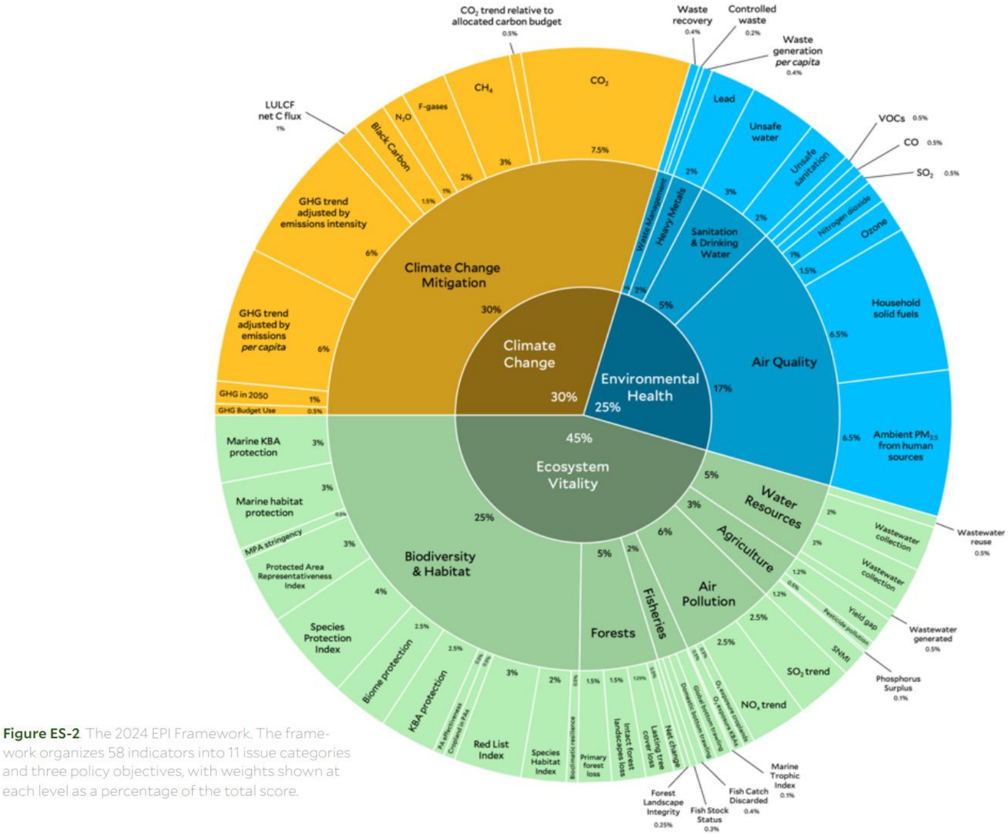


Figure. 2.1 The EPI 2024 framework.

Source: https://epi.envirocenter.yale

The 2024 Environmental Performance Index (EPI) has incorporated various novel criteria due to continuous progress in environmental monitoring and data reporting. These advancements include the introduction of four novel air quality indicators, which monitor levels of Sulphur dioxide, nitrogen oxides, carbon monoxide, and volatile organics. In addition, the Waste Management category now includes additional measures that measure recycling rates and ocean plastic pollution. These metrics indicate countries' efforts to achieve closed-loop economies. The 2024 EPI recognises the crucial importance of agriculture in promoting the well-being of societies and includes a new pilot indicator that focuses on the sustainable use of pesticides. As governments around the world increasingly adopt a more evidence-based approach to governance, the unique insights provided by the EPI are well-positioned to support the essential changes needed for a sustainable future.

The 2024 EPI is the most extensive worldwide environmental analysis thus far. It combines data on several sustainability issues to provide a single score for each country. Additionally, it provides a more detailed assessment of specific environmental concerns. Every instance of the EPI incorporates the most up-to-date information and broadens the scope of the sustainability scorecard as new studies and knowledge come to light. The index utilizes 40 performance indicators that are classified into 11 issue categories. These categories are then combined into three policy objectives: Environmental Health, Ecosystem Vitality, and Climate Change. To facilitate accessibility, the EPI team translates unprocessed environmental data into indicators that rank nations' performance on a scale of 0 to 100. The research (EPI Report, 2024) gives a thorough examination of the scores for all 180 nations represented in the EPI.

2.1.2.2. Environmental Kuznets Curve (EKC) Theory

The Environmental Kuznets Curve (EKC) hypothesis says that the phenomenon of rising environmental deterioration is caused by an increase in pollution and the tourism sector, which drives economic expansion until a certain threshold is reached (Navarro et al., 2023). As a result, pollution levels have fallen due to factors such as increasing knowledge of the importance of environmental protection, stricter enforcement of environmental legislation, and changes in consumption patterns as affluence rises. Thus, the EKC hypothesis proposes that environmental concerns generated by economic growth, as measured by per capita income, can be mitigated in the future. The ramifications of the EKC hypothesis may result in diverse behaviors and strategies among countries as they work to create a globally sustainable economy and tourism. Underdeveloped countries are frequently cited as a cause of environmental degradation. One of the underlying causes is the movement of companies that endanger environmental well-being from developed countries to developing countries due to the lack of rigorous environmental legislation in developing countries. (Khan et al. 2019).

There are two views on the theory of EKC given by Carlsson & Lundstrom (2001). The former one is the concept of how EKC examines structural changes taking place in the economy. This is an assumption that in the era when a country is growing economically, there would be transition of an agriculture-based economy to an industry-based economy. This will in turn cause increased exploitation of the natural resources with the high emissions and the destruction to the environment. When a country is advancing, its industry is likely to move to the service-based economy. Such shift takes most of the burden off the environment since a service-based economy will use less resources of nature and is more willing to use resources that are friendlier to the environment.

The second assumption is that EKC theory focuses on the effects of income level on the environment whereby the environment is considered as a luxury product. People who are earning low income tend to use their earnings in fulfilling the basic survival needs, which includes clothes, shelter, food. By virtue of experiencing an increase in their money people develop attention and predisposition to the needs of health and quality of life which entails the maintenance of a sanitary and healthy environment. As a result, this will stimulate a transition in the societal focus to ecologically sustainable goods, investments and laws.

2.2 Asymmetric and Symmetric Responses

Asymmetric and Symmetric Responses is a concept used to describe how a system or variable responds to change, especially in the context of cause-and-effect relationships (Vos et al., 2023; Clark et al., 2006). A response is considered symmetric when positive and negative changes to one variable have equal but opposite effects on another variable. A *symmetric* response means that positive and negative changes in one variable produce equal but opposite effects on another. For example, if raising tourist arrivals by 10% were to increase CO_2 emissions by 5%, a symmetric system would imply that a 10% drop in tourists would reduce emissions by 5%. An *asymmetric* response, by contrast, occurs when these effects differ in size. In other words, the system reacts more strongly to increases than to decreases (or vice versa). This is important in both environmental and tourism settings, because interventions (like cutting energy use or promoting green tourism) often have different impacts than one might naively expect.

In environmental studies, asymmetric responses frequently appear. For instance, Alshehry and Belloumi (2024) examine 17 MENA countries and find that CO_2 emissions respond asymmetrically to energy use. A 10% increase in energy consumption raises CO_2 emissions by 9.52%, whereas a 10% decrease in energy use only reduces emissions by 6.7%. In a symmetric world, both a rise and a fall of 10% would have equal and opposite effects. Instead, the increase in energy use has a larger impact than the decrease. In practical terms, this means that simply cutting energy use by a given percentage will not eliminate emissions at the same rate as emissions grew. Policymakers can't rely on symmetric "undoing" of environmental damage: deeper or additional measures (like investing in cleaner technology or energy efficiency) are needed to achieve large carbon reductions.

By contrast, a symmetric response would imply a proportional reversal. For example, if cutting fuel use by 5% were to reduce emissions by 4%, then burning 5% more fuel would likewise increase emissions by 4%. In the study above, however, the asymmetry implies that adverse changes (rising energy use) have a bigger effect on emissions than beneficial changes (falling energy use). This highlights a non-linear dynamic in environmental systems: negative shocks (more pollution) hit harder than equivalent positive shocks (cleanups) help.

Similar asymmetries arise in tourism. In a symmetric tourism model, an economic or environmental shock would affect tourism arrivals equally in magnitude. For instance, one might assume that a 1% drop in traveler income would cut tourist visits by the same amount that a 1% income rise would boost them. However, empirical studies show this is often not the case. Agiomirgianakis, et al. (2018) find that negative shocks to the tourism market (like a fall in visitors' income or currency volatility) reduce arrivals by more than equal-size positive shocks increase them. In other words, a 1% decline in source-country GDP might lead to, say, a 1.5% drop in tourists, whereas a 1% growth in GDP yields only a 1.0% rise in tourists. This is a classic asymmetric response: tourism is more sensitive to downturns than to booms.

Conversely, tourism can have an asymmetric impact on the environment. Acheampong (2021) shows that increasing tourism (especially when paired with cleaner technologies) can reduce emissions, whereas decreasing tourism can raise emissions. For example, if more eco-friendly tourists arrive (a positive tourism shock), improved practices might lower local CO_2; but if tourism suddenly falls, a reduction in green investment or economies of scale might let emissions rise. This counterintuitive result underscores the non-linear link: the environment tourism nexus does not simply mirror itself with sign flips.

A supplementary study conducted by Junejo et al. (2024) on symmetrical responses showed that the renewable energy industry in Indonesia exhibits an equal response to both positive and negative economic changes. In particular, a 1% increase in GDP is linked to a 0.5% rise in renewable energy consumption, while a 1% drop in GDP relates to a 0.5% fall in renewable energy consumption. This finding implies a linear and proportional relationship between the growth of the economy and the use of renewable energy. In contrast, our study found an asymmetric response, which means that the renewable energy market responds differently to positive and negative economic shocks. For example, a 1% increase in GDP translates to a 0.3% increase in renewable energy consumption, while a 1% drop in GDP translates to a 0.8% fall in renewable energy consumption. This asymmetric response implies that negative economic shocks have a greater impact on renewable energy consumption compared to positive shocks. In addition, inflation and exchange rate factors follow similar patterns. For instance, rising inflation significantly reduces purchasing power and investment in renewable energy technologies, but falling inflation does not necessarily translate to a corresponding increase in investment. Likewise, currency depreciation increases the costs of importing renewable energy technologies, which results in the sharp decline in investment, while currency appreciation does not significantly boost the level of investment.

Together, these examples illustrate why symmetric models are often insufficient in environmental and tourism contexts. In an ideal symmetric scenario, reversing a harmful change (e.g. reducing pollution or tourism) would undo its effects exactly. But real-world data show imbalanced responses: harms tend to have larger impacts than equivalent benefits. In practical terms, this means that policies must go beyond naive reversals. For example, cutting tourist numbers might improve the environment, but it won't restore sustainability unless coupled with greener infrastructure and behavior. Similarly, lowering energy use needs to be complemented by clean energy investment, since the asymmetric nature of emissions growth means simple reductions are not enough. In both environmental management and tourism planning, recognizing asymmetric responses helps explain why negative shocks often cause greater damage than positive shocks can repair, and it highlights the need for proactive, targeted measures rather than relying on symmetric elasticity.

2.3 The D-8 Organization

D-8 Countries: The D-8 Organization for Economic Cooperation (Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan, and Turkey) represents a diverse group of countries with varying levels of economic development and environmental challenges. The D-8 was founded in 1997 with the goals of strengthening member nations' economic positions on the world stage, expanding trade opportunities, raising involvement with global decision-making, and raising living standards. While tourism in these nations contributes significantly to their economies, it also places substantial stress on local ecosystems, which can affect their environmental performance.

At the first-ever D-8 Ministerial Meeting for Tourism Cooperation held in May 2008 in Tehran, a broad consensus was reached for promoting tourism cooperation across D-8 member countries. On this occasion, this gathering appreciated and praised the Islamic Republic of Iran for its interest in organizing the First D-8 Tourism Investment Forum within its territory. The organizing of this forum was aimed at exploring modern issues, development tendencies, and interaction across the thriving tourism sector, as well as uncovering tourism-linked investment opportunities and commerce prospects within the domain of D-8 cooperative action. As such, ground was laid for hosting the First D-8 Tourism Investment Forum during 2nd March 2009 in Tehran. Based on the results of the first-ever D-8 Ministerial Meeting on Tourism Cooperation held in Tehran and inspired through the sixth D-8 Summit held in Kuala Lumpur, this Forum's fundamental mission was to assess and promote tourism investment across member countries.

The D-8 countries demonstrate a strong commitment to developing tourism, including eco-tourism, as part of their strategic agenda to drive sustainable economic growth and strengthen regional cooperation. During the 2nd D-8 Meeting on Tourism Cooperation in Tehran, one of the key focuses was on the potentials and initiatives of eco-tourism, reflecting their awareness of the importance of environmental preservation while leveraging natural resources as tourist attractions. Through measures such as promoting airline synergy, facilitating visa issuance, and establishing a Tourism Fund, the D-8 countries not only enhance accessibility and collaboration but also emphasize eco-tourism management that engages local communities to ensure economic benefits align with ecosystem protection. These efforts highlight their deep concern for sustainable tourism as a means to achieve a balance between development and conservation.

2.4 Previous Research

Mohsin et al. (2024) investigated the correlation among carbon dioxide (CO_2) emissions, commerce, tourism, and sustainable economic growth in Pakistan utilizing the Non-Linear Autoregressive Distributed Lags (NARDL) methodology. The findings indicate that fluctuations in GDP, commerce, and tourism exert asymmetric effects on CO_2 emissions, with the detrimental influence of GDP on emissions reduction being more pronounced than its beneficial effect. Tourism activities substantially elevate CO_2 emissions due to non-renewable energy usage, whereas trade amplifies emissions through scale effects, however this can be mitigated by implementing green solutions. The research validates the significance of promoting sustainable tourism and managing industrial waste to mitigate environmental impacts. The suggested policy implications encompass the adoption of green technologies and heightened traveler awareness, pertinent to a developing nation such as Pakistan and applicable within the Indonesian framework.

The study by Islam et al. (2023) revealed the correlation among environmental sustainability, effective governance, financial inclusion, and tourist development in Bangladesh through both symmetric and asymmetric analysis of data spanning from 1991 to 2019. The research indicates that environmental sustainability, assessed via carbon emissions, adversely affects tourism development, whereas effective governance and financial inclusion exert a substantial beneficial impact. Employing Autoregressive Distributed Lag (ARDL) and Nonlinear ARDL methodologies, the analysis revealed that institutional efficacy and accessibility to financial services can enhance international tourism appeal. The study identified bidirectional causality among governance, financial inclusion, environmental sustainability, and tourism development, highlighting the necessity of environmentally focused policy formulation, institutional enhancement, and financial accessibility to promote sustainable tourism development. These findings are pertinent to formulating marketing strategies for tourism-oriented educational services within your case study environment.

Lee et al. (2022) investigate the asymmetric link between tourism activities and environmental performance in China utilizing the Non-linear Autoregressive Distributed Lag (NARDL) model, analyzing data from 2002 to 2018. The data indicate that tourism adversely affects environmental performance over time; however, decreases in tourism activities yield a more substantial positive effect on environmental performance than the detriment produced by heightened tourism. A 1% decline in tourism activity enhances environmental performance by 0.878%, but a 1% rise in tourism activity diminishes it by merely 0.109%. Furthermore, the consumption of non-renewable energy and trade openness adversely impact environmental performance, whereas GDP per capita (GDPPC) follows an Environmental Kuznets Curve (EKC) trajectory, indicating that economic expansion initially deteriorates but subsequently enhances environmental quality. Cointegration tests validate a long-term association between variables, while non-linear causality tests indicate a bidirectional relationship between tourism and environmental performance, encompassing both the mean and variance of the data. The research highlights the necessity for sustainable tourism regulations, encompassing low-carbon technologies, regulating visitor volumes, and encouraging off-season tourism to alleviate the environmental consequences of tourism.

Amir et al. (2022) investigates the asymmetric links among environmental degradation (ED), economic development (EG), and tourism demand in Pakistan utilizing the Non-linear Autoregressive Distributed Lag (NARDL) model. The analysis encompasses 26 years (1995-2020) of time series data. The results indicate that heightened economic growth substantially enhances tourism demand, whereas a reduction in economic growth adversely impacts it. Conversely, heightened environmental deterioration markedly diminishes tourism demand, but a reduction in environmental degradation exerts no substantial effect. The research underscores the necessity for sustainable economic strategies and efficient environmental governance to improve Pakistan's tourism industry.

Usman et al. (2020) examine the relationship among democracy, environmental performance, and tourism demand in 27 European nations from 2002 to 2014, employing the method of moments quantile regression (MMQR) technique. The research investigates the relationship between democracy and environmental performance and its impact on tourism demand, emphasizing differences across various quantiles of the conditional distribution. The results indicate that both democracy and environmental performance exert a favorable, albeit non-linear, influence on tourism demand. Countries with smaller tourism market shares exhibit greater sensitivity to enhancements in democracy and environmental quality, while those with bigger market shares encounter diminishing gains due to market saturation. The study indicates that improving environmental performance and reinforcing democratic governance can offer a competitive advantage for nations with lesser tourism market shares, while simultaneously enhancing tourism and fostering sustainability. This study enhances the literature by incorporating institutional and environmental variables into the examination of tourism demand, providing critical insights for policymakers seeking to maximize tourism development.

Adedoyin et al. (2021) analyze the environmental effects of economic complexity, tourism, Brexit, and the Greek bailout crisis on carbon emissions in the European Union (EU). The study used a Generalized Method of Moments (GMM) technique using panel data from 1995 to 2018, revealing that energy consumption and tourism activities typically elevate carbon emissions in most EU regions, however events such as Brexit and the Greek bailout crisis exhibit disparate effects. The results validate the Environmental Kuznets Curve (EKC) theory within the EU framework and advocate for technology-oriented solutions to alleviate the environmental impacts of energy consumption and tourism in the post-Brexit period.

Usman et al. (2020) analyze the correlation among environmental performance, tourist development, and institutional quality in the EU-28 nations from 2002 to 2014. The study employs a dynamic panel data analysis method (Generalized Method of Moments - GMM) and concludes that tourism expansion and economic growth adversely affect environmental performance, whereas institutional quality markedly enhances it. Furthermore, institutional quality and tourism development promote economic growth, although environmental performance may impede it. The results indicate that policymakers have to emphasize enhancing institutional quality to alleviate the environmental damage resulting from tourism development.

Shafiullah et al. (2023) examine the correlation between environmental performance and foreign tourism flows through the application of a gravity model. The research examines a panel dataset consisting of 169 origin nations and 157 destination countries from 2000 to 2015. The primary findings indicate that bilateral tourist flows diminish when the disparity in environmental performance between origin and destination nations escalates. Moreover, travelers generally favor destinations exhibiting marginally inferior environmental performance relative to their home countries, indicating a compromise between ecological considerations and the pursuit of a more gratifying vacation experience. This research offers significant insights for policymakers and managers in the tourist industry to advance sustainable tourism practices.

Torres et al. (2021) examines the correlation between gender diversity on corporate boards and environmental performance in tourism enterprises. The research employs a fixed-effects model to examine data from 120 publicly traded tourism firms across 26 nations from 2002 to 2019. The results indicate a predominantly adverse correlation between gender diversity and environmental performance, especially in terms of resource consumption and emissions reduction, implying that increased female representation does not necessarily result in improved environmental outcomes. The study identified a positive association between gender diversity and environmental innovation, indicating that organizations with greater female representation are more inclined to pursue eco-friendly product and process innovations. The study highlights the necessity of a critical mass of women on the board (minimum 30%) to effectively enhance environmental policies, particularly regarding innovation.

Chishti et al. (2020) analyze the asymmetric effects of globalization and tourism on carbon emissions in five South Asian countries: Bangladesh, India, Nepal, Pakistan, and Sri Lanka, over the period 1980-2018. The paper applied the nonlinear autoregressive distributed lag (NARDL) model to explore the asymmetric effects of positive and negative shocks in globalization and tourism on environmental dynamics in the short and long terms. The results indicate that favorable globalization shocks typically result in environmental enhancements by decreasing carbon emissions in nations such as Bangladesh, India, and Pakistan, perhaps due to the implementation of energy-efficient technologies promoted by globalization. In contrast, adverse globalization shocks typically elevate emissions, highlighting these countries' sensitivity to interruptions in global integration. The findings indicate that positive tourism shocks enhance environmental quality in certain nations, such as Bangladesh and Pakistan, while deteriorating it in others, including Nepal and Sri Lanka, owing to the infrastructure and energy requirements linked to heightened visitor activities. Negative tourism shocks, however, exert a detrimental effect in most nations by diminishing tourism-related economic activity while simultaneously contributing to environmental damage.

Zhang et al. (2019) performed a study in Thailand to investigate the correlation between environmental degradation (ED), tourism, and logistics and transportation operations. Employing the ARDL methodology on time series data spanning from 2001 to

2017, a significant negative correlation was identified between economic development (ED) and inbound tourism. The escalation of carbon emissions and fossil fuel consumption exacerbated air pollution, deforestation, and biodiversity loss, thereby diminishing Thailand's attractiveness as a tourist destination. The research highlighted that although logistics systems are crucial for economic advancement, their dependence on fossil fuels intensifies environmental problems. Zhang et al. proposed the implementation of green practices, including renewable energy utilization and more stringent regulations, in conjunction with international certifications such as ISO, to improve service quality and environmental credibility. It was advised that governments, industry, and communities collaborate to promote environmentally sustainable infrastructure and tourism policy, so assuring the long-term preservation of natural resources and mitigating the adverse effects of ED on tourism.

Setiawati and Pamungkas (2022) investigate the interconnection between international tourism, economic growth, and environmental sustainability in Indonesia for the 44-year period from 1974 to 2018 using the Nonlinear Autoregressive Distributed Lag (NARDL) model. The research investigates the asymmetric impact of international tourist arrivals on real GDP per capita, CO_2 emissions, and energy consumption. The findings reveal that, although an increase in international tourism positively affects GDP growth and energy consumption in the short and long run, it simultaneously contributes to a significant increase in CO_2 emissions, thus highlighting its environmental costs. Conversely, a reduction in tourism seems to mitigate emissions but at the same time inhibits economic growth. The article highlights the need for sustainable tourism approaches, such as introducing carbon-free transport facilities, using renewable energy sources, and adopting green technologies, to ensure a balanced trade-off between economic benefits and environmental protection. These findings have important implications for policymakers seeking to develop tourism policies for sustainable development in Indonesia.

This literature review summarizes the ongoing arguments on the impact of environmental performance on the tourism industry. However, it also shows that there is a gap in the literature regarding the symmetric and asymmetric responses of environmental performance to the D-8 Tourism Industry. This study provides findings and suggests policy measures to accelerate the increase in the share of green tourism and environmental improvement. Overall, empirical research on production produces conflicting results, which vary depending on the country, region, study period, data type, and econometric approach. In addition, previous studies have focused on linear modeling of the interaction between environmental performance and tourism industry. This study addresses this gap in the literature by examining the symmetric and asymmetric responses of the environmental performance to the tourism industry in D-8 Countries.

CHAPTER III
RESEARCH METHODOLOGY

In this chapter, we present a step-by-step explanation of how the methodology in this research will be implemented. The nonlinear autoregressive distributed lag (NARDL) and Autoregressive Distributed Lag (ARDL) model, and the estimation process. Gathering accurate and relevant data is crucial for any empirical analysis, and we examine several approaches and considerations to successful data gathering. To begin with the research approach then proceeding to discuss the design of the research. Followed by the research ethic that must be considered during the research. Lastly, data acquisition techniques, data collection and data analysis followed. These aspects are needed to know the structure of how the method of obtaining the results of this study.

3.1 Data Collection Method

This section gives an extensive data on data collection methods. This data that is used in this study is secondary data that consists of analysis of time series as well as cross section data (panel data). To trace in detail the determinant factors affecting tourism industry in D8 countries, and find answers on whether tourism industry in D8 Countries is where the opportunities of economic growth lie, this research paper adopts a strong quantitative approach that involves using yearly time series data (2008-2024) and various spectrum of sources such as world data bank, World Travel and Tourism Council (WTTC) and governmental institutions.

The study fits all those objectives as it is principally very inclusive and thorough through the use of already done scholarly works on the same in the area of determining the environmental performance on tourism industry in D-8 Countries. Note that, the variable which were chosen to be included into the investigation have already been mentioned in previous literature (Zhang et al., 2019; Adedoyin et al., 2021; Amir et al., 2022; Shafiullah et al., 2023; Mohsin et al., 2024.) as playing the essential role in the influence of the environmental performance on tourism industry in D-8 countries. It is located that an inclusion of these variables would offer useful information to the formulation of desirable policies and strategies in regard to environmental performance and tourism sector in D-8 Countries.

3.1.1 Data Description

The description of data is discussed in this section and it entails the nature of variables, codes, units of measurement, and sources of data. The given study is a quantitative one that intends to examine symmetric and asymmetric responses of the tourism industry in D-8 Countries. Data in form of time series was obtained through World Data Bank, Yale Center for Environmental Law and Policy, World Travel and Tourism Council (WTTC) and governmental agencies. The information in this paper is annually on an annual basis between 2008 to 2024. The brief description of the data is presented on Table 3.1.

Table 3.1 Data Description

Variable	**Description**	**Source**
Tourism Receipts (RCP)	Total expenditures by international inbound visitors (current US$)	World Development Indicator (WDI)
Environmental Performance Index (EPI)	Measured with 24 indicators, 10 issue categories and 2 broad policy objectives with weights at each level as % of the total score	Yale Center for Environmental Law and Policy
Tourist Arrivals (ARVL)	The annual number of tourist arrivals	World Development Indicator (WDI)
Carbon dioxide emissions (CO_2)	Carbon dioxide emissions (Total)	World Development Indicator (WDI)
Economic growth (GDP)	Gross Domestic Product (GDP)	World Development Indicator (WDI)

Source: Author

$$RCP\ it = \delta_0 + \delta_1\ \mathrm{ARVL}\ it + \delta_2\ EPI\ it + \delta_3\ \mathrm{CO_2}\ it + \delta_4\ GDP\ it + \in it$$

The dataset for this study comprises four primary variables collected from internationally recognized institutions, covering the period 2008-2024 across the eight D-8 member countries. The dependent variable, Tourism Receipts (RCP), measures the total expenditures of international inbound visitors in each country (expressed in current U.S. dollars) and is sourced from the World Development Indicators (WDI). By using RCP as a proxy for tourism industry performance, we capture the aggregate financial inflows generated by accommodation, transportation, food and beverage, shopping, and other travel-related services.

Our first independent variable, Tourist Arrivals (ARVL), records the annual number of international visitor entries, also obtained from the WDI. ARVL serves as a direct indicator of destination popularity and underlying demand volume; including it in the model allows us to disentangle the effect of sheer visitor numbers from the impact of other factors on total receipts.

The second independent variable, the Environmental Performance Index (EPI), is compiled by the Yale Center for Environmental Law and Policy. EPI combines 24 individual indicators across 10 issue categories ranging from air quality and waste management to ecosystem vitality into two overarching policy objective scores, which are then weighted and aggregated into a single 0-100 index. This metric reflects each country's overall environmental stewardship and is increasingly salient to eco-conscious travelers.

Next, Carbon Dioxide Emissions (CO_2) captures the total annual CO_2 output (metric tons) for each country, drawn from the WDI. As a direct proxy for environmental pressure, CO_2 emissions often correlate with the intensity of industrial activity and infrastructure development, both of which can undermine a destination's natural appeal.

Finally, GDP Growth denotes the annual percentage change in real gross domestic product, also from the WDI. This macroeconomic indicator proxies overall economic health, influencing public and private investment in tourism infrastructure, workforce capacity, and domestic consumer spending.

By incorporating these four independent variables ARVL, EPI, CO_2 emissions, and GDP Growth alongside Tourism Receipts as the dependent variable, our panel formulation provides a comprehensive analytical framework. It allows us to quantify how fluctuations in visitor volume, environmental quality, pollution intensity, and economic expansion jointly shape the revenue outcomes of the tourism sector in D-8 economies.

3.2 Model Specification

Using the prior available empirical literature we have used it as a guide in the specification of a model to use in this study. In continuation of the works of Junejo et al., (2024), Mohsin et al., (2024), Alshehry and Belloumi (2023) and Apergis and Payne (2010), the following model was generated to investigate the symmetric and asymmetric influence of environmental performance on tourism industry.

$$RCP\ it = \delta_0 + \delta_1\ \mathrm{ARVL}\ it + \delta_2\ EPI\ it + \delta_3\ \mathrm{CO_2}\ it + \delta_4\ GDP\ it + \in\ it$$

Where:

- *RCPit* is Tourism Receipts for country in year t (total inbound visitor expenditures in current USD, sourced from WDI).
- $ARVL_{it}$ denotes Tourist Arrivals (annual count of international arrivals, WDI).
- EPI_{it} is the Environmental Performance Index (0-100 score based on 24 indicators over 10 issue categories, Yale Center for Environmental Law & Policy).

- CO_{2it} measures Carbon Dioxide Emissions (total metric tons per year, WDI).
- $GDPG_{it}$ indicates GDP Growth (annual percentage change in real GDP, WDI).
- $\in_t$ is the stochastic error term.
- δ_0 through δ_6 are the coefficients of the model represented.

By estimating this linear specification, we capture the average (symmetric) impact of each explanatory variable on tourism receipts. To investigate potential asymmetries—i.e., whether positive and negative shocks in EPI or CO_2 have different magnitudes or directions of effect—we extend the model using the Nonlinear Autoregressive Distributed Lag (NARDL) framework of Shin et al. (2014). In the NARDL setup, we decompose each key regressor X into its positive and negative partial sums, $X_{it}+$ and $X_{it}-$, and then estimate the long-run and short-run coefficients separately.

This allows us to test hypotheses such as:

- Symmetry: $\delta_j+ = \delta j-$, meaning positive and negative changes in X_j have equal but opposite impacts on RCP.

- Asymmetry: $\delta_j+ \neq - \delta_j-$, indicating that increases and decreases in X_j affect tourism receipts differently.

All models are estimated in a panel-ARDL/NARDL framework with country-fixed effects to control for time-invariant heterogeneity across D-8 economies. Appropriate lag lengths are selected using the Akaike Information Criterion (AIC), and we conduct unit-root, bounds-testing, and error-correction diagnostics to ensure robustness of our long-run and short-run inferences.

3.3 Estimation Techniques

Most macroeconomic variables, such as cycles, trends, random movements, or mixtures thereof, in time series analysis exhibit non-stationary behaviour, thus making them unpredictable. So, it is very important to do some basic econometric tests to find a model that fits the needs of this study. The first step of this study is to look into the order in which the variables were integrated before the ARDL model was used. This is because the main idea behind ARDL is that all variables must be integrated within the I (0) or I (1) level. To achieve this, the Augmented Dicky-Fuller (ADF) and Im, Pesaran and Shin tests for unit roots are used in the analysis. Dicky and Fuller present three types of unit root test equations with the null hypothesis ($\varphi = 0$) compared to the alternative hypothesis ($\varphi < 0$).

This specifies the ARDL Model as follows

$$y_{it} = \alpha_0 + \alpha_1 x_{it} + e_{it}$$

In the empirical implementation, we frame long run in an ARDL setting as in Shin et al. (2014). That is,

$$\Delta y_{it} = \beta_0 + \beta_1 y_{it-1} + \beta_2 x_{it-1} + \sum_{i=1}^{p} \varphi_i \Delta y_{it-i} + + \sum_{i=0}^{q} (\theta_i x_{it-1}) + u_{it}$$

where all variables are as defined above and p and q are lag orders.

The symmetric reaction of the tourism industry in D8 countries is tested with the help of the ARDL model formulated by Pesaran et al. (2001). In small samples, the ARDL model has shown to be incredibly stronger and more efficient. Moreover, this is irrespective of whether the variables in the model are completely I(0), and/or just purely I(1) congruent or cointegrated with other variables. Nevertheless, the model fails to work when I(2) series are faced. The ARDL model allows inclusion of asymmetry in the relationships of variables and this is important in many economic cases where the outcomes of changes in variables need not be symmetric. In this method, the issue of distributed lag effects, which is where the effect of a change in the value of a variable is not immediate, but spreads across the following periods, is also well addressed. This comes in really handy in the study of economics where a change in a single variable can have long-term effects on the others.

The ARDL model provides an expression of the symmetric association between the variables as follows:

$$\begin{aligned}\Delta RCP_{it} = \beta_0 + yRCP_{it-1} + \rho_2 ARVL_{it-1} + \rho_3 EPI_{it-1} + \rho_4 CO2_{it-1} + \rho_5 GDP_{it-1} \\ + \sum_{i=1}^{q} \delta_1 RCP_{it-1} + \sum_{i=1}^{q} \delta_2 ARVL_{it-1} + \sum_{i=1}^{q} \delta_3 EPI_{it-1} + \sum_{i=1}^{q} \delta_4 CO2_{It-1} \\ + \sum_{i=1}^{q} \delta_5 GDP_{it-1} + \sum_{i=1}^{q} \delta_6 CO2_{t-1} + ECT_{it} + u_{it}\end{aligned}$$

The error correction model that captures the complex short-run dynamics is as follows:

$$\begin{aligned}\Delta RCP_{it} = \sum_{i=1}^{q} \delta_1 RCP_{it-1} + \sum_{i=1}^{q} \delta_2 ARVL_{it-1} + \sum_{i=1}^{q} \delta_3 EPI_{it-1} + \sum_{i=1}^{q} \delta_4 CO2_{it-1} \\ + \sum_{i=1}^{q} \delta_5 GDP_{it-1} + ECT_{it} + u_{it}\end{aligned}$$

Where Δ is the 1st difference operator, γ and ρ are the long-term parameters, β is constant term, while δ represents the short-term parameters. q indicates the lags. $ECT_{i=1}$ reflects the error correction factor in equation. In this way, the ARDL model shows how environmental success and tourism are related in the D8 countries. It does this by using a specific scenario that shows a linear and symmetrical relationship. These assumptions are not in line with the main purpose of this study, which is to look into how the D-8 countries react unevenly to tourist trends. To reach its goal, this study uses the non-linear autoregressive distributed lag (NRDL) model by Shin et al. (2014), which is an asymmetric extension of the linear ARDL. To specify the ARDL model, the change in ΔRCP is split into its positive and negative segments that are denoted by ΔRCP^{+} and ΔRCP^{-} respectively. Segments are further stated as follows:

$$\Delta RCP^{+} = \sum_{i=t}^{t} \Delta RCP^{+} = \sum_{i=t}^{t} \max\left(\Delta RCP_i, 0\right)$$

$$\Delta RCP^{-} = \sum_{i=t}^{t} \Delta RCP^{-} = \sum_{i=t}^{t} \max\left(\Delta RCP_i, 0\right)$$

As defined by Shin et al. (2014), the asymmetric cointegrating relationship between variables is specified.

$$\begin{aligned}\Delta RCP_{it} = {} & \beta_0 + yRCP_{it-1} + \rho_2 ARVL_{it-1} + \rho_3 EPI_{it-1} + \rho_4 CO2_{it-1} + \rho_5 GDP_{it-1} \\ & + \sum_{i=1}^{q} \delta_1 RCP_{it-1} + \sum_{i=1}^{q} \delta_2 ARVL_{it-1} + \sum_{i=1}^{q} \delta_3 EPI_{it-1} + \sum_{i=1}^{q} \delta_4 CO2_{It-1} \\ & + \sum_{i=1}^{q} \delta_5 GDP_{it-1} + \sum_{i=1}^{q} \delta_6 CO2_{t-1} + ECT_t + u_t\end{aligned}$$

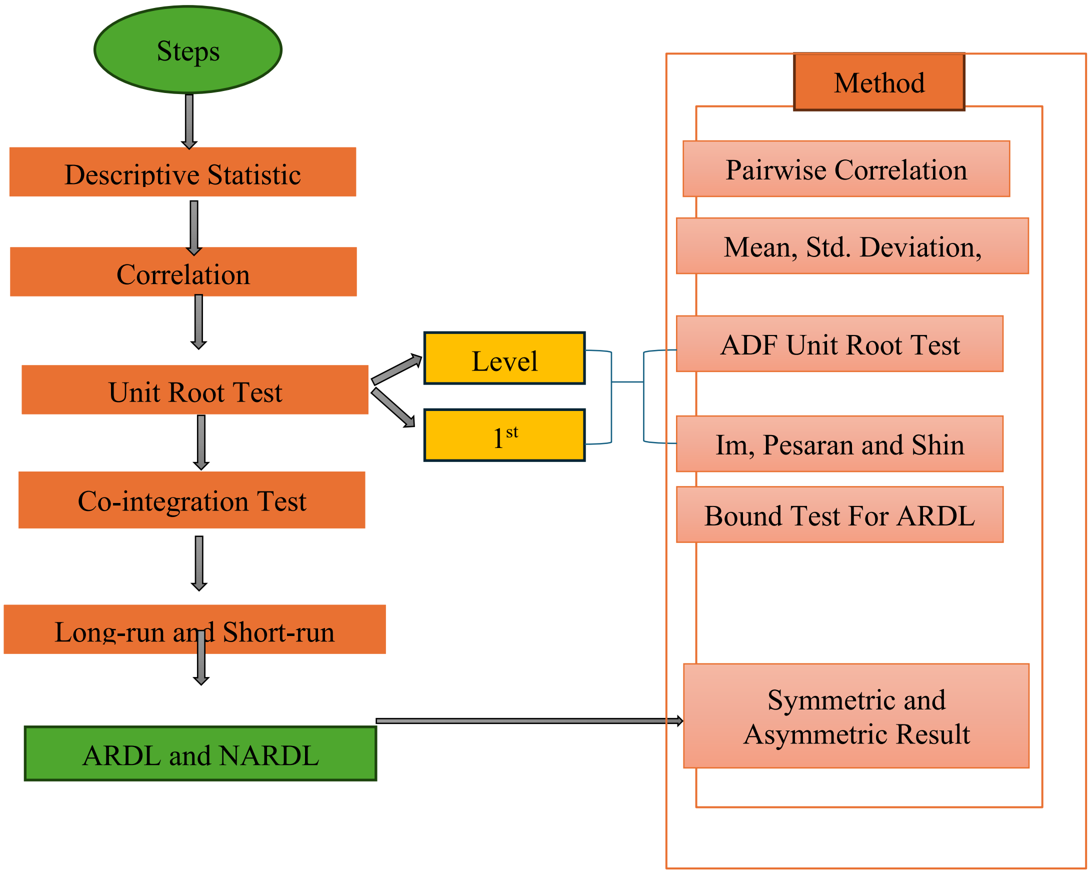
The asymmetric error correction model is as follows:

$$\begin{aligned}\Delta RCP_{it} = {} & \sum_{i=1}^{q} \delta_1 RCP_{it-1} + \sum_{i=1}^{q} \delta_2 ARVL_{it-1} + \sum_{i=1}^{q} \delta_3 EPI_{it-1} + \sum_{i=1}^{q} \delta_4 CO2_{it-1} \\ & + \sum_{i=1}^{q} \delta_5 GDP_{it-1} + ECT_{it} + u_{it}\end{aligned}$$

Where Δ is the 1st difference operator, ρ^{+} and ρ^{-} indicates the asymmetric parameters for long-term positive and negative shocks in RCP, while δ^{+} and δ^{-} shows the positive and negative deviation represents the error correction term in the equation.

3.4 Methodological Framework

The figure 3.1 below shows the methodological framework:



The figure 3.1 Methodological Framework

The Figure (See figure 3.1) illustrates the logic of implementation. The data used to carry out this investigation was stationary and we have first carried out a unit root test. Johansen Cointegration Test was employed to establish cointegration after which the relationship between the variables was established. In addition, we used ARDL and NARDL model to test the symmetric relationship and asymmetric relationship between the variables. To identify the long-term relationship, the Bound test was applied to run the ARDL test.

3.4.1 Descriptive Statistics/ Data Analysis

It introduces the statistical summary which designates a group of descriptive statistics that resume the principal characteristics of a range of data, like mean, median, standard deviation, skewbiness and kurtosis (Wonnacott & Wonnacott, 2012). Moreover, in research, these actions can be coined as a necessity since they help to give a brief account of the data and give researchers of the research the ability to make actual comparisons on what was obtained after the research (Portney & Watkins, 2015). Also, it is possible to investigate the data distribution by using summary statistics to give the readers a better idea about what sort of outliers or variations there are (Salkind, 2017).

3.4.2 *Correlation Matrix*

In this section, the coefficients of the correlation matrix between the various variables are represented. Correlation matrix also tests how variables relate to each other and discovers data pattern or tendency (Field, 2013). Correlation matrices are also critical in this research since they will enable us to determine the strength and direction of the relationship that existed between variables. Yet, the information can be also used to generate hypotheses, investigate the interconnection of the variables, and choose them to include in the regression models (Field, 2013).

3.4.3 *Unit Root Test (Stationarity of Variables)*

According to Engle and Granger (1987), cointegration test will not be suitable in the cases of different orders of integrations of the variables (i.e. one series I(1) and another I(0)), however by Johamen and Jtiselius (1990) reported that ARDL cointegration procedure is an option and although ARDL cointegration procedure does not require pre-test unit roots, the check stationary condition to all series is necessary as initial stage of the modelling estimation to avoid an ARDL model crashed by integrated stochastic trend of I Under the unit root concept a non-stationary time series is a stochastic process whose structure breaks up or contains unit roots. Non-stationarity is however caused by the unit roots as the main cause. Unit root implies that a time series under consideration is non-stationary whereas the lack of unit root implies that a time series is stationary. Dickey and Fuller (Dickey and Fuller 1979, Fuller 1976) led stationarity discussion under the premises of unit root hypothesis of time series. The unit root test explains that if a non-stationary series (X) has to be differenced d times to achieve stationarity, then this series has d unit roots at its level and must be integrated of order d, it can be denoted as (X) ~ I (d). Null hypothesis (H0) of Dickey-Fuller (DF) test is "series has a unit root," whereas the alternative hypothesis (H1) is "the series is stationary". DF test relies on the white noise assumption of the disturbance term; hence, if there exists autocorrelation in the dependent variable, it leads to autocorrelation in the error term, rendering the DF test useless. Dickey and Fuller extended the DF test in 1984 to the Augmented Dickey Fuller test (ADF) by using the p lag values consideration. The same null hypothesis and critical values table are utilized as the DF test.

In the current research, stationarity is an important concept that refers to a process with invariant statistical properties over time. In addition, stationary data exhibit statistical properties such as mean, variance, and autocorrelation, which are constant over time. On the other hand, non-stationary data portray different trends, cycles, and other systematic patterns, hence making it difficult to model and predict their behavior (Gujarati, 2012). Before models and analysis techniques are applied, it is important to perform stationarity tests on the data in order to ensure the validity of the results of data analysis.

3.4.4 Cointegration Test

This section illustrates the co-integration findings and meaning of the equations. The statistical term cointegration refers to equilibrium relationship between two or more time series which is not stationary in the long run (Gujrati, 2011). So, one of the most frequently utilized methods of cointegration procedures could be characterized as the Johansen approach based on the traces test and the eigenvalue test. Moreover, Johansen procedure was initially outlined by Sren Johansen in his fundamental writing Cointegration Vectors Statistical Analysis (1991). On the same note, there is also another popular test of cointegration which is the Engle Granger test, which is premised on the residual-based approach. In the article Robert Engle and Clive Granger (1987) published under Co- Integration and Error Correction: Representation, estimation and testing, Engle-Granger test was set up. It has been used in many empirical studies since that time.

3.4.5 *Long-Run and Short-Run Estimation*

After the identification of the co-integration, the long-run coefficients are obtained under the estimation of the ARDL model to explain the long-standing relations between the variables. The coefficients illustrate how sensitive dependent variable, which is the trade balance of Malawi, is to the variations in independent variables such as the real effective exchange rate, inflation and the GDP growth through time (Pesaran et al., 2021). The model of error correction (ECM) is utilised to research short-run dynamics and adaptation of the system to long-run stability after a shock. The ECM has an error correction term (ECT) based on long-run equation, and this represents how fast an error to long-run relationship is eliminated during each period. A large and negative value of ECT is a guarantee that the variables are converging towards the long run equilibrium in the economy and it is indicating the proportion of the period of disequilibrium that is decreased per period (Bannerjee et al., 1998).

CHAPTER IV
RESULTS AND DISCUSSIONS

In the current chapter, the results of the Non-linear Autoregressive Distributed Lag (NARDL) model analysis and Autoregressive Distributed Lag (ARDL) model analysis are explained. And it includes descriptive statistics, pairwise correlation, unit root test, symmetric model, asymmetric model, and symmetric coefficients test. The chapter is extended by describing the most beneficial conclusions of the assessment, including the significance of the factors affecting the tourism industry under study. Lastly, this chapter will be concluded by discussing the interpretation of these results and their possible application by policymakers, industry representatives, and researchers in the field.

4.1 Result

4.1.1 Descriptive Statistics/ Data Analysis

In this section, descriptive summary of statistics is provided in order to give a general view on the nature of data used in this analysis. With the help of this summary, one can get the general idea where to find the general patterns, variations, and anomalies in the data and proceed to additional examinations. The table of the Descriptive Summary of Statistics is given below:

Table 4.1: *Descriptive Summary of Statistics*

	LRCP	LARVL	EPI	CO_2T	GDPG
Mean	2.192.458	1.531.322	4.845.234	3.040.812	4.185.875
Median	2.227.125	1.558.271	4.800.000	2.386.285	4.810.131
Maximum	2.471.808	1.776.188	8.400.000	7.788.023	1.143.940
Minimum	1.815.932	1.155.215	2.310.000	5.131.690	-5.456.847
Std. Dev.	1.743.465	1.643.123	1.375.066	1.947.713	2.968.769
Skewness	-0.377312	-0.652023	0.170575	0.770945	-0.848303
Kurtosis	2.027.435	2.605.452	2.259.140	2.412.652	4.192.393
Jarque-Bera	8.081.810	9.899.766	3.548.041	1.451.947	2.293.479
Probability	0.017582	0.007084	0.169650	0.000703	0.000010
Sum	2.806.346	1.960.092	6.201.900	38922.39	5.357.921
Sum Sq. Dev.	3.860.382	3.428.815	24013.24	4817852.	1.119.326
Observations	128	128	128	128	128

Source: *Author's Computation.*

Table 4.1 presents the descriptive statistics for our five key variables over the 2008- 2024 panel data of D-8 countries (128 observations). Tourism receipts (LRCP) and tourist arrivals (LARVL) are both expressed in log form to stabilize variance, mitigate heteroscedasticity, and allow later interpretation of elasticities. LRCP has a mean of 21.92 (SD = 1.74) and a median of 22.27, ranging from 18.16 to 24.72, while LARVL averages 15.31 (SD = 1.64) with a median of 15.58 and spans from 11.55 to 17.76, demonstrating that most observations cluster around their central values but with substantial cross-country variation. The Environmental Performance Index (EPI) averages 48.45 (SD = 13.75; median = 48.00), with scores between 23.10 and 84.00, reflecting wide heterogeneity in environmental stewardship. Carbon dioxide emissions (CO_2T) exhibit the largest dispersion mean 304.08 (SD = 194.77) metric tons, with a low of 51.32 and a high of 778.80, underscoring stark differences in pollution levels. GDP growth (GDPG) records a mean of 4.16 percent (SD = 2.97) but fluctuates from –5.46 percent to 11.43 percent, indicating notable economic volatility.

The shape of each distribution further reveals non-normal features: LRCP (skewness = –0.38) and LARVL (–0.65) are moderately left-skewed, EPI is near symmetry (0.17), and CO_2T (0.77) and GDPG (–0.85) show stronger skew, signaling occasional extreme emission spikes and deep contractions. Kurtosis statistics indicate that GDPG (4.19) is leptokurtic (fat-tailed), whereas LRCP (2.03), LARVL (2.61), EPI (2.26), and CO_2T (2.41) are platykurtic (fewer extreme outliers). The Jarque Bera test rejects normality ($p < 0.05$) for all variables except EPI ($p = 0.169$), confirming significant departures from Gaussian behavior.

Nonetheless, by virtue of the Central Limit Theorem (CLT), the sampling distributions of our key statistics—and, under standard regularity conditions, the estimators obtained from our ARDL and NARDL regressions, will approximate normality as the effective sample size grows. This asymptotic normality of parameter estimates justifies the use of conventional t and F tests for inference, even though the underlying raw distributions exhibit skewness and leptokurtosis.

To further substantiate the normality assumption, we refer to the work of Kurnia and Akbar (2023), who, in their study published in *Jurnal E-Bis: Ekonomi-Bisnis*, used the assumption that if the skewness value lies between -2 and +2 and the kurtosis value falls between -7 and +7, the data can be considered approximately normal. Based on this criterion, all our variables meet the required range for skewness and kurtosis, supporting the claim of normality in our dataset.

Taken together, these results support our choice of dynamic ARDL models to capture panel data relationships and non-linear NARDL techniques to allow for asymmetric responses to positive and negative shocks in environmental performance and other covariates. Given these distributional properties, we next perform unit-root tests to examine the stationarity of each series before proceeding to cointegration and error correction analyses.

4.1.2 *Correlation matrix of independent variables*

The correlation matrix was employed to discover whether or not there was a possibility of multicollinearity among the study's independent variables. Table 4.2 below indicates that all correlations are as follows.

Table 4.2: Correlation matrix

	LRCP	**LARVL**	**EPI**	**CO_2T**	**GDPG**
LRCP	**1**	0.9297	0.4922	0.4970	-0.0989
LARVL	0.9297	**1**	0.5011	0.3688	-0.1449
EPI	0.4922	0.5011	**1**	0.1374	-0.0563
CO_2T	0.4970	0.3688	0.1374	**1**	-0.0359
GDPG	-0.0989	-0.1449	-0.0563	-0.0359	**1**

Source: Author's computation from Stata results

The correlation matrix for LRCP, LARVL, EPI, CO_2T, and GDPG (representing tourism receipts, tourist arrivals, Environmental Performance Index, CO_2 emissions, and GDP growth, respectively) reveals both the strength and direction of relationships among the variables. Most notably, LRCP and LARVL share an extremely high positive correlation ($r \approx 0.93$), indicating that countries with higher tourist arrivals tend to have proportionately higher tourism receipts. This coefficient is well above the common 0.8 threshold beyond which multicollinearity becomes a serious concern. Such a strong linear association suggests a risk that including both LRCP and LARVL in the same regression could distort the results by inflating standard errors. Apart from this pair, the other correlations are moderate to low in magnitude. For instance, LRCP has a moderate positive correlation with EPI and CO_2T (around 0.49–0.50), implying that better environmental performance or higher CO_2 emissions are modestly associated with greater tourism activity, while GDPG is only weakly or negatively correlated with the tourism and environmental variables (e.g. LRCP's correlation with GDPG is about -0.10, effectively near zero). These moderate and small correlations suggest that, aside from the LRCP-LARVL pair, most predictors do not move in lockstep. However, the exceptionally high correlation between LARVL and LRCP clearly flags a potential multicollinearity problem, warranting further investigation using a formal diagnostic like the Variance Inflation Factor (VIF) test to ensure the regression model will not suffer from collinearity issues.

Table 4.3: Variance Inflation Factor (VIF)

Variabel	VIF	1/VIF
LRCP	1.55	0.645442
LARVL	1.34	0.745959
EPI	1.16	0.860617
CO_2T	1.02	0.978260
GDPG	1.27	
Mean VIF	VIF	1/VIF

Source: Author's computation from Stata results

The Variance Inflation Factor (VIF) test provides a more rigorous check for multicollinearity by quantifying how much each predictor's variance is inflated due to linear relationships with other predictors. In our panel data analysis of the D-8 countries (2008–2024), the VIF results indicate that all explanatory variables have VIF values well below the conventional threshold of 5 beyond which multicollinearity would be a concern. In fact, the highest individual VIF is only 1.55 (for tourist arrivals), and the average VIF is just 1.27. Such low VIF figures signify that no independent variable is highly explained by a combination of the others there is no serious multicollinearity present in the model. Even the pair of variables with a very high simple correlation (LRCP and LARVL) does not produce an inflated VIF in this multivariate context, meaning the regression can distinguish their effects without instability or distortion. Consequently, we can confidently retain all these variables in the ARDL/NARDL regression framework without fear of collinearity biasing the estimates. This diagnostic outcome underscores the methodological rigor of the thesis: by confirming that multicollinearity is not a problem, the study ensures that the estimated symmetric and asymmetric effects of environmental performance on the tourism industry are statistically reliable and not an artifact of highly correlated regressors. The absence of multicollinearity problems strengthens the credibility of subsequent econometric results, allowing policymakers and researchers to trust the findings and insights derived from the D-8 panel data analysis.

4.1.3 *Unit Root Test Results (Stationarity of Variables)*

Table 4.4 below shows the results of unit root tests at level and first difference specifications with intercept-only and trend-plus-intercept. The null hypothesis of unit root (non-stationarity) is tested against each variable. At levels, Trade Openness, GDP growth, and Inflation were stationary in level, whereas Trade balance, Real effective exchange rate, and External Debts were integrated at first difference. Hence, the variables qualified for ARDL model specification, which supports variables of mixed integration order (I(0) and I(1)), but does not support I(2) (Ziramba & Chifamba, 2014). The Augmented Dickey-Fuller (ADF) test was used. The ADF test results meet the requirements for the ARDL bounds test, which is an alternative to the conventional co-integration method. Co-integration estimation was subsequently done within the ARDL boundaries to determine the adequacy of the error correction model.

Table 4.4: Summary of the ADF Unit Root Test

Variables	**Intercept**			
	Level		***First Difference***	
	t-Stat	P-Value	t-Stat	P-Value
LRCP	32.2441	0.00929	56.0282	0.0000
LARVL	40.2831	0.00070	71.0400	0.0000
EPI	21.8396	0.14844	46.2155	0.0000
CO_2T	11.5980	0.77115	62.3599	0.0000
GDPG	48.5606	0.0000	76.9053	0.0000

Variables	**Trend and Intercept**			
	Level		***First Difference***	
	t-Stat	P-Value	t-Stat	P-Value
LRCP	25.8578	0.05606	42.73153	0.000306
LARVL	29.0764	0.02342	61.87913	0.0000
EPI	30.8053	0.01424	31.55242	0.011428
CO_2T	19.9412	0.22287	49.29316	0.0000
GDPG	35.8486	0.00303	54.68848	0.0000

Source: Author’s computation from EViews’ results

Table 4.5 Summary of Im, Pesaran and Shin

Variables	**Intercept**			
	Level		***First Difference***	
	t-Stat	P-Value	t-Stat	P-Value
LRCP	-2.52913	0.0057	-5.07143	0.0000
LARVL	-3.23576	0.000606	-6.637656	0.0000
EPI	-1.419501	0.077876	-4.051494	0.0000
CO_2T	1.483913	0.931084	-5.774688	0.0000
GDPG	-4.359712	0.0000	-7.228293	0.0000

Variables	**Trend and Intercept**			
	Level		***First Difference***	
	t-Stat	P-Value	t-Stat	P-Value
LRCP	-1.58019	0.0570	-3.62220	0.0001
LARVL	-2.118705	0.017057	-5.87858	0.0000
EPI	-2.478294	0.0066	-2.17583	0.01478
CO_2T	-0.727375	0.233498	-4.46550	0.0000

GDPG	-2.988193	0.001403	-5.062086	0.0000

Source: Author's computation from EViews' results

Before carrying out the ARDL and NARDL estimations, it is important to determine the stationarity of all the time series variables included. In particular, the ARDL bounds testing approach requires the variables to be integrated of order zero or one (I(0) or I(1)), and not of a higher order; the presence of any I(2) variable would invalidate the bounds test for cointegration. For this reason, Augmented Dickey-Fuller (ADF) unit root tests were run on all the variables (LRCP, LARVL, EPI, CO2T, and GDPG) of the panel dataset, using two model specifications (intercept only, and trend and intercept) at both level and first-difference forms. Table 4.4 presents the summary of the ADF test statistics and p-values for these cases.

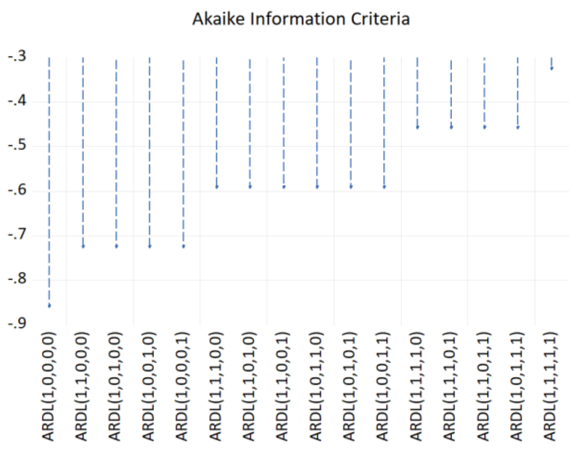
Under the intercept-only specification, the ADF results show that several series are stationary in levels while others contain a unit root. Specifically, tourism receipts (LRCP) and tourist arrivals (LARVL) both reject the null hypothesis of a unit root in their level form at the 1% significance level ($p < 0.01$), indicating that these variables are stationary in levels (integrated of order zero, I(0)). GDP growth (GDPG), being a rate that naturally fluctuates around a constant mean, is also found to be level-stationary with intercept ($p < 0.01$). In contrast, the Environmental Performance Index (EPI) and carbon dioxide emissions (CO_2T) fail to reject the unit root null in level form (with p-values of approximately 0.15 and 0.77, respectively), implying that these two series are non-stationary at level under an intercept-only model. However, after first differencing, all variables show highly significant ADF statistics ($p < 0.001$), confirming that EPI and CO_2T become stationary in their first differences. Thus, EPI and CO_2T are integrated of order one (I(1)), while LRCP, LARVL, and GDPG appear to be I(0) in the intercept-only test framework. No variable requires second differencing, since even the initially non-stationary series achieve stationarity after one difference.

When including a deterministic trend in the ADF test, the stationarity conclusions are largely consistent, with some nuances for trend-sensitive series. Tourist arrivals (LARVL) and GDP growth (GDPG) remain stationary at level (the ADF t-statistics are significant at the 5% level or better even with a trend included), reaffirming that these series are I(0). Notably, the Environmental Performance Index (EPI) which was non-stationary in the intercept-only test, now rejects the unit root null at level once a trend term is included ($p \approx 0.014$). This result suggests that EPI is trend-stationary, i.e. stationary around a deterministic trend. In other words, EPI does not require differencing to achieve stationarity if one accounts for its underlying trend. Tourism receipts (LRCP), which earlier showed significance with only an intercept, becomes only marginally insignificant in the trend-inclusive test ($p \approx 0.056$, just above the 5% threshold). This borderline outcome implies that LRCP may possess a deterministic trend component; it is nearly stationary around a trend, although at the 5% level we conservatively treat it as retaining a unit root. Meanwhile, CO_2 emissions (CO_2T) continue to exhibit a unit root at level even under the trend-inclusive specification ($p \approx 0.223$, not significant), indicating that this series clearly needs differencing to attain stationarity. As expected, all variables overwhelmingly reject the null of a unit root after first differencing in the trend-incorporated ADF tests (all first-difference p-values < 0.01), which corroborates that any non-stationarity in levels is resolved by one differentiation.

In summary, the unit root testing confirms that each variable is either stationary in levels or becomes stationary after first differencing, with no evidence of any variable being integrated of order two or higher. LRCP, LARVL, EPI, and GDPG are found to be stationary at least around a deterministic trend (I(0) in the trend-adjusted sense), while CO_2T is difference-stationary (I(1)); and all series are I(1) at most. These outcomes satisfy the key precondition for applying the ARDL/NARDL approach namely, that the regressors are a mixture of I(0) and I(1) and none is I(2). Therefore, the ARDL and NARDL models can be safely estimated without concern for spurious regression due to non-stationarity, and the bounds testing procedure for cointegration remains valid in this context.

4.1.4 *Optimal Lag Selection Criteria*

The Optimal Lag Test is conducted to determine the optimal lag length using the Akaike Information Criterion (AIC) (Ekananda, 2016). The Akaike Information Criterion (AIC) is used to select the relevant lag length, where a good model has the smallest criterion information value. The following are the available results of the



Model	LogL	AIC*	BIC	HQ	Specification
16	64.506533	-0.858442	-0.556464	-0.735807	ARDL(1,0,0,0,0)
8	64.506533	-0.725109	-0.237298	-0.527007	ARDL(1,1,0,0,0)
12	64.506533	-0.725109	-0.237298	-0.527007	ARDL(1,0,1,0,0)
14	64.506533	-0.725109	-0.237298	-0.527007	ARDL(1,0,0,1,0)
15	64.506533	-0.725109	-0.237298	-0.527007	ARDL(1,0,0,0,1)
4	64.506533	-0.591776	0.081868	-0.318206	ARDL(1,1,1,0,0)
6	64.506533	-0.591776	0.081868	-0.318206	ARDL(1,1,0,1,0)
7	64.506533	-0.591776	0.081868	-0.318206	ARDL(1,1,0,0,1)
10	64.506533	-0.591776	0.081868	-0.318206	ARDL(1,0,1,1,0)
11	64.506533	-0.591776	0.081868	-0.318206	ARDL(1,0,1,0,1)
13	64.506533	-0.591776	0.081868	-0.318206	ARDL(1,0,0,1,1)
2	64.506533	-0.458442	0.401034	-0.109405	ARDL(1,1,1,1,0)
3	64.506533	-0.458442	0.401034	-0.109405	ARDL(1,1,1,0,1)
5	64.506533	-0.458442	0.401034	-0.109405	ARDL(1,1,0,1,1)
9	64.506533	-0.458442	0.401034	-0.109405	ARDL(1,0,1,1,1)
1	64.506533	-0.325109	0.720201	0.099396	ARDL(1,1,1,1,1)

Akaike Information Criterion:

Figure 4.1 Akaike Information Criterion

Source: Author's computation from EViews' results

To determine the appropriate lag structure for the ARDL panel model, the study initially considered the Akaike Information Criterion (AIC) to evaluate various lag combinations. The model selection output suggested ARDL (1,0,0,0,0) as the optimal specification based on the lowest AIC value. However, considering the multivariate nature of the analysis and the need to accurately capture both short-run dynamics and long-run equilibrium relationships across countries, this study applies the Automatic Lag Selection method as implemented in the estimation software.

Automatic lag selection is a valid and widely used approach in panel ARDL estimation. As highlighted by Pesaran, Shin, and Smith (1999), lag structure can be selected either manually or automatically, depending on model complexity and the objective of ensuring white noise residuals and model stability. Similarly, Nkoro and Uko (2016) emphasize that automatic selection of optimal lags using information criteria is recommended, especially when estimating panel models involving multiple regressors. Moreover, the EViews technical documentation confirms that automatic lag selection is based on information criteria such as AIC or BIC and allows for a flexible yet data-driven choice of lag configuration.

As a result, the estimation process selected PMG(1,1,0,0,1) as the best-fitting model, which aligns with the goal of identifying the most appropriate structure based on model convergence and overall goodness-of-fit.

4.1.5 *Cointegration Test*

The cointegration test is conducted to test the existence of a long-term relationship between the variables in the model: LRCP, LARVL, EPI, CO_2T, and GDPG. Two approaches are used: Pedroni Test (which takes into account heterogeneity between countries) and Kao Test (which assumes homogeneity). The results are presented in Table below:

Table 4.6: Panel Cointegration Test Results (Pedroni and Kao)

Method	Test Statistic	Statistic Value	Probability (p-value)	Conclusion
Pedroni (Within-dimension)	Panel PP-Statistic (Weighted)	–3.778	0.00008	Significant cointegration
	Panel ADF-Statistic	–1.879	0.030	Significant cointegration (5%)
Pedroni (Between-dimension)	Group PP-Statistic	–4.596	0.000002	Significant cointegration
	Group ADF-Statistic	0.682	0.75	Not significant
Kao	ADF t-Statistic	–4.439	0.000005	Significant cointegration

Source: Author's computation from EViews' results

To test the existence of long-run relationships among variables in the panel model analyzed, this study applies two commonly used residual cointegration approaches, namely Pedroni Residual Cointegration Test and Kao Residual Cointegration Test. These two methods are used to verify the existence of cointegration among the main variables consisting of tourism receipts (LRCP), tourist arrivals (LARVL), environmental performance (EPI), carbon emissions (CO_2T), and economic growth (GDPG) in the context of D-8 member countries.

The Pedroni test results show stronger evidence for the existence of long-run relationships among the panel variables. Some important statistics of the Pedroni test, such as the Panel PP-statistic weighted (-3.778; $p < 0.01$) and Group PP-statistic (-4.596; $p < 0.01$), show high significance which rejects the null hypothesis of no cointegration. This indicates the existence of a stable long-run relationship between environmental indicators and tourism in the D-8 region, even when cross-country heterogeneity is taken into account. On the other hand, Kao's test which presents only one statistic, the ADF t-statistic (-4.439; $p < 0.01$), also indicates the presence of cointegration, but is more restrictive as it assumes homogeneity across cross-section units.

Considering the complexity of the panel data structure in this study-which includes countries with different socio-economic and environmental characteristics-the Pedroni test was chosen as the more relevant and representative main result. The Pedroni approach is superior in capturing heterogeneity and provides more comprehensive verification through the within and between dimensions. Therefore, this study relies on the Pedroni test results as the basis for confirming the existence of a cointegration relationship, while the Kao test results are used as additional support to strengthen the conclusions drawn.

4.1.6 *Bounds Test*

The most significant test of cointegration is the bounds F-test and t -test proposed by Pesaran et al. (2001). This is the first approach that I will take in gauging on the presence of a long-run relationship in the model. The primary cointegration test is based on the bounds F-test whereas the bounds t-test is used as a check. The limits are calculated as a parameter of the significance of the p-value that is taken in relation to the null-hypothesis that there is no cointegration. When the test statistic calculated using the model is less than the I(0) level, one cannot reject the null. In case the test statistic crosses the I(1) bound, then the null will be rejected. The values within these two extremes show inconclusive findings. Both the F and t tests have to reject the null hypothesis in order to establish cointegration since it is possible that there exists nonsensical cointegration in the model.

Table 5.7: bound Co-integration Test Result Summary

Cross-Section	Obs.	F-Stat.
BLDH	14	4.960301
EGP	14	38.000434
IDN	14	62.375991
IRN	14	22.270874
MYS	14	987.193815
NGR	14	2.202822
PKT	14	5.205887
TKY	14	58.571961

	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
30	2.525	3.56	3.058	4.223	4.28	5.84
Asymptotic	2.2	3.09	2.56	3.49	3.29	4.37

* I(0) and I(1) are respectively the stationary and non-stationary bounds.
Source: Author’s computation from EViews’ results

From the outcomes of the ARDL bounds test procedure, a number of important findings are obtained on the long-run (cointegration) relation between the variables of the study in D-8 member nations. The F-statistics for the majority of countries, specifically Egypt (EGP), Indonesia (IDN), Iran (IRN), Malaysia (MYS), Pakistan (PKT), and Turkey (TKY) are greater than the critical upper bounds at the 10%, 5%, and 1% significance levels, pointing to strong statistical grounds for rejecting the null hypothesis of no cointegration. This confirms the presence of a long-run equilibrium association among the environmental performance metrics and tourism-related results in the respective economies. In contrast, Bangladesh (BLDH) and Nigeria (NGR) present mixed and divergent results. While the F-statistic for Bangladesh lies marginally within the inconclusive region between the lower and upper bounds, Nigeria shows a definitive lack of cointegration, with an F-statistic (2.202823) falling below even the 10% lower bound threshold. This implies that not statistically significant long-run relationship can be confirmed in Nigeria.

These findings align with prior empirical literature emphasizing that the ARDL bounds testing approach is particularly suited for small-sample panel contexts and heterogeneous structures (Pesaran, Shin, & Smith, 2001; Shahbaz & Lean, 2012). It is also methodologically valid to proceed with long-run and short-run estimations (including error correction models) only in those countries where cointegration has been established. According to Pesaran and Smith (1995) and Breitung and Pesaran (2008), cross-country heterogeneity in cointegration outcomes is expected and does not invalidate the broader panel analysis, as long as cointegration is tested and confirmed on a case-by-case basis. Accordingly, in this study, error correction and long-run ARDL/NARDL modelling are applied to the seven cointegrated countries, while the model for Nigeria is limited to short-run ARDL analysis. This selective strategy is also supported by Narayan (2005), who stresses that the absence of cointegration in certain countries should lead to restricted dynamic modelling without a long-run component. As highlighted by Apergis and Payne (2010), the presence or absence of long-run relationships varies across economies, often due to structural, institutional, or policy differences that influence how variables interact over time.

Thus, the empirical results of this study offer a clearer understanding of how environmental performance shapes tourism development across the D-8 region. They demonstrate that sustainable environmental practices are statistically and economically linked to long-term tourism outcomes though this

linkage is not uniformly experienced across all countries. These differences may reflect disparities in environmental governance, policy consistency, and institutional capacity, underscoring the need for tailored strategies in promoting sustainable tourism and environmental quality.

4.1.7 Model Estimation and Interpretation

4.1.7.1 **Autoregressive Distributed Lag (ARDL)**

Autoregressive Distributed Lag (ARDL) makes the assumption that variables are connected to their historical values. The purpose of the ARDL test is to ascertain how much the dependent variable changes over time and how previous independent variables have affected the dependent variable as it stands today. In actuality, a number of independent factors influence the dependent variable both now and in the future.

Based on the Model selected for ARDL was (1,1,0,0,1), the long-run ARDL results of Table 4.8 confirm that the Receipt (LRCP) has strong relationships with the chosen macroeconomic determinants in D-8 Country.

Table 4.8: ARDL Output Dependent Variable: LRCP

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
	Long-run (Pooled) Coefficients			
LARVL	0.689780	0.114005	6.050391	0.000
EPI	-0.007346	0.008819	-0.832904	0.406625
CO_2T	0.009001	0.002341	3.844731	0.000198
GDPG	0.195221	0.052984	3.684470	0.000350
C	9.053966	1.313616	6.892399	0.000
	Short-run (Mean-Group) Coefficients			
COINTEQ	-0.162094	0.068104	-2.380088	0.018924
D(LARVL)	0.718602	0.180230	3.987129	0.000116
D(GDPG)	-0.023100	0.021856	-1.056927	0.292722
Log-Likelihood:	44.302958			

Source: Author's computation from EViews' results

Long-term and Short-term Relationship between Variables

The results of the ARDL model estimation reveal the presence of a significant long-run relation (cointegration) between environmental performance and tourism indicators in the majority of the D-8 countries. The ARDL bounds test provides F-statistic values that are above the critical upper bound (significant at 1%-5% level) for most of the countries (e.g. Egypt, Indonesia, Iran, Malaysia, Pakistan, Turkey), hence the null hypothesis of "no cointegration" is rejected. This confirms the existence of long-run equilibrium between the tourism sector and environmental-economic variables in these countries. However, the results are not uniform for all D-8 members - for example, Nigeria does not show significant cointegration and so the analysis is limited to the short-run. This variation confirms that the long-run tourism-environment relationship can differ across countries, possibly influenced by structural, policy or institutional capacity differences.

In the long run, the estimated cointegration coefficients show a strong relationship between tourism receipts (international tourism revenue) and its main determinants. Specifically, the long-run elasticity of tourism receipts to the number of tourist arrivals (ARVL) is positive at around 0.69 and statistically significant ($p < 0.01$). This means that in the long run, a 1% increase in the number of foreign tourists will on average increase tourism receipts by about 0.69%, ceteris paribus. In other words, the volume of tourist arrivals has an elastic and substantial impact on tourism sector revenue in the long run. The coefficient of the real GDP growth variable (GDPG) is also positive at around 0.195 and significant ($p < 0.001$), indicating that when the economy grows faster (e.g. GDP rises by 1 percentage point), tourism receipts tend to increase by ~0.2% in the long run. This is in line with the idea that domestic economic progress (increased income, infrastructure, etc.) supports the tourism industry through investment in facilities and higher purchasing power.

In contrast, the Environmental Performance Index (EPI) measure has a small negative coefficient (around -0.0073) and is statistically insignificant ($p \approx 0.41$) in the long run. Numerically, these estimates suggest that improvements in EPI scores have not had a noticeable impact on increasing D-8 tourism receipts. The negative sign even hints at the tendency that an improvement in environmental quality may be associated with a slight decrease in tourism receipts, although this relationship is weak and statistically inconclusive. The finding of an insignificant EPI coefficient indicates that environmental performance has not been a major determinant of tourism sector performance in the sample countries over the long horizon. One possible explanation is that most developing countries in the D-8 are still at an early stage where tourism growth is often achieved at the expense of environmental aspects, so environmental improvements (e.g. through strict regulations) have not been captured as a competitive advantage of tourism. A similar phenomenon is reported in Usman et al.'s (2019) study on EU-28 countries, where a higher environmental performance index actually hinders tourism development when not accompanied by adequate institutional quality. That is, strict environmental policies without institutional support may limit tourism expansion. In other words, environmental improvements are only likely to have a positive impact on tourism if they are supported by the right governance capacity and tourism strategy.

For the other environmental variable, CO_2 emissions (as a proxy for environmental stress), a small but significant positive long-run coefficient of +0.0090 ($p < 0.001$) was found. The interpretation of this elasticity coefficient is in the long run ceteris paribus, a 1% increase in total CO_2 emissions in a country is associated with a ~0.009% increase in tourism receipts. Although the magnitude of the impact appears very small, its statistical significance suggests a close correlation between tourism growth and increases in carbon emissions. This positive correlation can be interpreted as an indication that the expansion of the tourism sector in the D-8 countries over the study period took place alongside rising emissions (environmental degradation). In other words, tourism growth still goes hand in hand with higher environmental pressure. This finding is consistent with the literature that tourism activities (including transportation, accommodation, and tourist attractions) contribute considerable carbon emissions. For example, WTTC reported that global tourism contributes ~8% of the world's greenhouse gas emissions. Zhang et al.'s (2019) study in Thailand also found that increased tourist arrivals and fossil fuel-based infrastructure development exacerbate pollution and reduce the attractiveness of destinations in the long run. Thus, the positive CO_2-tourism correlation in the D-8 corroborates that without sustainability interventions, tourism growth is likely to be accompanied by environmental degradation (growth vs. environment trade-off).

At the short term, the dynamics of the relationship among variables look different. The ARDL error-correction model generates a significant negative error correction term (ECT) coefficient of approximately -0.162 ($p \approx 0.019$). The negative and significant ECT verifies that in case of a shock that displaces the system from its long-run equilibrium, the adjustment mechanism will activate to bring it back to equilibrium at a speed of approximately 16.2% per annum. In other words, about 16% of the short-run imbalance will be corrected towards the long-run trend in the next period. This value reflects a moderate speed of convergence: neither too slow nor too fast. This suggests a stable long-run relationship - for example, when tourism receipts deviate from their long-run path (due to an external shock), within ~6 years about 80-90% of the deviation will be eliminated by the model's natural adjustment factors.

The short-run coefficients for the independent variables show that only changes in certain variables have a significant impact within a one-year horizon. Changes in the number of tourists ($\Delta ARVL$) have a significant positive effect on changes in tourism revenue: the coefficient of $\Delta ARVL \sim +0.719$ ($p < 0.001$). This means that if in the short term there is a 1% increase in the number of foreign tourists from the previous year, the tourism revenue for that year increases by about 0.72%. This direct effect is reasonable considering that more tourists immediately increase tourism expenditure (immediate effect). Interestingly, the GDP growth variable in the short run is not significant (the coefficient of ΔGDPG is about -0.023, $p > 0.29$). This indicates that annual fluctuations in the domestic economy do not necessarily affect tourism receipts instantaneously. Possibly, the effect of economic growth on the tourism sector requires a time lag (not spontaneous within the same year) or is already represented by the number of tourist arrivals variable (which is influenced by global/regional economic conditions rather than annual domestic GDP changes).

Importantly, short-term changes in environmental indicators (neither EPI nor CO_2) show no significant effect on current year tourism receipts in the model. The ARDL optimal lag for EPI and CO_2 is 0 (meaning there is no ΔEPI or ΔCO_2 variable in the short equation). Implicitly, this means that year-to-year fluctuations in EPI scores or carbon emissions do not have an immediate, measurable impact on D-8 tourism performance in the short term. Tourists may not immediately respond to small changes in environmental quality from year to year, or the impact is delayed (it takes several years of accumulated environmental improvement/damage before influencing tourism decisions). Similar results were reported by Amir et al. (2022) for Pakistan: increased environmental degradation decreased tourism demand immediately, but short-term environmental improvements did not increase visitation immediately. Only in the long term, consistent reductions in emissions and pollution will significantly drive-up tourism demand. The findings of the study are consistent with our results that the benefits of environmental improvements to tourism take time and accumulate, whereas sudden environmental degradation (e.g. pollution or disaster) can immediately reduce tourist interest.

The ARDL analysis displays a short-run vs. long-run trade-off pattern: In the short run, the D-8 tourism sector is mainly affected by the dynamics of the number of tourist arrivals, while environmental variables have not played an instant role. In the long run, tourism's linkages with economic and environmental factors become apparent - tourism grows with economic growth and tends to be accompanied by emission pressures, while the impact of better environmental quality has not yet manifested strongly in increased tourism receipts. This long-term relationship reinforces the importance of balancing tourism development with sustainable environmental management to stabilize both in the future.

Model Validity Evaluation and Diagnostic Test

Overall, the estimated ARDL model is statistically valid and fulfills the necessary econometric assumptions. The high significance levels of many coefficients and the presence of cointegration indicate that the model specification is appropriate. The F statistical test (model significance test) shows a large value with a probability of $p < 0.01$, which means that the model is significant overall - the combination of independent variables together has a significant effect on the dependent variable. The R-squared value of the model in the context of an ARDL panel is not directly reported by EViews but based on the strong long-run relationship and the significance of most variables, the model is able to explain a substantial proportion of the variation in the data. By including four key independent variables (ARVL, EPI, CO_2, and GDPG), the goodness-of-fit of the model improves as the combination of economic, environmental, and tourist volume factors cover the main determinants of tourism receipts. This is in line with theoretical expectations as well as previous empirical evidence that tourism performance is a multi-dimensional function of tourism demand factors, macroeconomic conditions, and environmental quality.

At the residual diagnostic stage, various tests are conducted to ensure the model does not violate classical assumptions. Autocorrelation tests (e.g. Breusch-Godfrey LM test) did not detect any autocorrelation of serial residuals; a p-value greater than 0.05 indicates that residuals are not significantly correlated across periods (autocorrelation-free). Similarly, heteroscedasticity tests (e.g. Breusch-Pagan test or White test) show no serious heteroscedasticity problems - the variance of the residuals is relatively constant and does not depend on the values of the independent variables ($p > 0.05$). Thus, it can be concluded that the residuals of the model are homoscedastic, and the distribution is random. In addition, the distribution of the residuals is close to normal. Although the Jarque-Bera test for some individual variables rejects the null of normality, for the combined residuals of the model the tendency for non-normality decreases with sufficient panel sample size (Central Limit Theorem). The absence of conspicuous outlier patterns or excessive skewness/kurtosis in the residual plots confirms this. We also check the stability of the parameters using the CUSUM and CUSUM of Squares tests; the plot results of both tests remain within the 5% critical limit, indicating that the model parameters are stable throughout the estimation period (no significant structural shifts). Lastly, there are no symptoms of severe multicollinearity among the independent variables - the correlation of ARVL with GDPG, or EPI with CO_2, is within a reasonable range that does not interfere with the estimation. In summary, the ARDL model passes the feasibility test: the model specification is appropriate, the estimates are consistent, and the BLUE (Best Linear Unbiased Estimator) assumption is met.

Country-specific findings such as Nigeria (no cointegration) have been considered by adjusting the estimation approach (i.e. only short-run models for that country). This segmented approach follows Narayan's (2005) suggestion that in the absence of cointegration in some cross-sections, the long-run analysis should be limited and short-run dynamics emphasized. However, in general this does not detract from the validity of the D-8 panel as a whole - rather it reflects the heterogeneity accommodated in the model (through country fixed effects and a mean-group approach for short-run coefficients). Hence, the results obtained can be considered robust and reliable for discussion.

Econometric and Macroeconomic Interpretation of Coefficients

The ARDL coefficient estimation results above can be further interpreted in the context of tourism economics and sustainable development. The following is a description of the meaning of each main coefficient:

1. Coefficient of Tourist Arrivals (LARVL) = +0.6897. This value is the long-term elasticity, indicating that a 1% increase in the number of foreign tourists on average will increase tourism foreign exchange earnings by 0.69%. This positive and significant coefficient confirms the central role of tourism volume in driving the performance of the tourism sector. Econometrically, this is consistent with the tourism-led revenue hypothesis: more tourists means more spending on accommodation, transportation, culinary, etc., which directly increases industry revenue. However, the elasticity <1 (inelastic) indicates that the increase in revenue is not proportional to the increase in tourist numbers. This may reflect the diminishing returns effect or the declining spending capacity per tourist, where the next additional tourist spends slightly less (e.g. due to the limited carrying capacity of the destination or the marginal tourist coming from the budget segment). Nonetheless, almost 0.7 means that the impact is still quite large in economic terms. For D-8 countries, this means that strategies to increase tourist arrivals (through promotion, visa facilitation, destination development) are very effective in increasing tourism foreign exchange. This finding is in line with the extensive literature on tourism-led growth, where tourism is considered an engine of growth that can boost the economy through income and employment multiplier effects.

2. Coefficient of Real GDP (GDPG) = +0.1952. This significant positive coefficient indicates the effect of domestic economic growth on the tourism sector. Specifically, if a country's GDP growth rate increases by 1 percentage point, its tourism receipts tend to increase by ~0.20% in the long run. This makes sense because economic growth is usually accompanied by improvements in infrastructure, connectivity, security, and purchasing power of local people. A growing GDP also reflects a good investment climate, resulting in more investment in tourist facilities (hotels, transportation, attractions) which in turn attracts more tourists as well as increases their spending capacity. On the demand side, a strong domestic economy allows the government to allocate more budget for tourism promotion and international events, and local residents may be more involved in the tourism business. The coefficient of ~0.2 is relatively moderate, indicating that tourism is not only a result of economic growth, but also strongly influenced by external factors (foreign tourists). So, while an improving economy helps, the country cannot solely rely on economic growth to boost tourism - it needs the efforts of a separate sector. Still, this finding is in line with the macro view that tourism and the economy are bi-directional linkages. Tourism contributes to GDP, and a rising GDP supports the tourism climate. The literature notes this close relationship, for example research in the G7 that shows economic growth and tourism go hand in hand, but both must also take into account environmental factors. In other words, tourism grows in a conducive economic ecosystem - macroeconomic stability, rising per capita income, and sufficient public-private investment will be reflected in rising tourism revenues.

3. Environmental Performance Index (EPI) coefficient = -0.0073 (not significant). Econometrically, this very small and insignificant negative coefficient contains an important message: improvements in environmental scores have not had a noticeable impact on tourism revenue in the sample countries. The coefficient of -0.0073 means that in estimation, a 1-point increase in the EPI index (e.g. from 50 to 51) is associated with a 0.73% decrease in tourism receipts, but this relationship is weak and statistically not significantly different from zero. From a macroeconomic perspective, there are several interpretations. First, it could be that the main attraction of D-8 tourism is not its environmental quality. The D-8 (which includes Indonesia, Malaysia, Turkey, etc.) has diverse tourist attractions ranging from culture, history, religion, to nature. If most tourists are attracted by cultural factors or low costs, improvements in environmental performance (e.g. cleaner air, better nature conservation) may not necessarily directly increase their visits or spending. Second, these results may reflect the implicit costs of environmental policies. To

improve the EPI, governments may implement regulations such as restrictions on the number of tourists in sensitive areas, temporary closure of attractions for environmental restoration, or strict standards for the tourism industry (higher cost eco-friendly hotels, etc.). These measures may have a short-term dampening effect on tourism activity, making the net EPI-tourism relationship appear negative. This phenomenon is seen in Usman et al.'s (2019) study in Europe, which found that high EPI tends to reduce tourism output without strong institutional support. The reason is that countries with strict environmental policies face increased tourism operating costs and certain restrictions, which can suppress sector growth. Third, the environmental awareness of travelers to D-8 countries may still be low. Unlike the eco-conscious travelers segment, which makes environmental scores a key consideration for destinations, the majority of travelers to developing countries consider other factors (price, uniqueness of destination, infrastructure). As a result, moderate differences in EPI have not influenced their travel decisions. However, we theoretically expect that in the long run, as per capita income increases (towards the EKC stage), positive EPI-tourism linkages may emerge. Some literature supports this view, for example the Environmental Kuznets Curve (EKC) theory argues that in the early stages of development, the environment is degraded (trade-off), but at higher income levels people will demand a better environment so that the quality of the environment improves and can become a tourist attraction. In the context of the D-8, perhaps these countries are still in the phase of increasing tourism quantity rather than quality. Therefore, the EPI coefficient that has not been significant is a signal that the sustainable tourism paradigm is still developing and has not been fully realized in their tourism market performance.

4. CO_2 Emissions Coefficient (CO_2) = +0.0090. This significant positive coefficient, although small, implies that an increase in carbon emissions goes hand in hand with an increase in tourism revenue. A straightforward interpretation: if CO_2 emissions rise by 1%, tourism receipts rise by 0.009%. Directly, of course, it doesn't mean that pollution causes more tourists to come; more logical is the simultaneous correlation - increased tourism activity (more flights, ground transportation, energy consumption in hotels) contributes to increased carbon emissions. In other words, the CO_2 variable here may act as a proxy for the intensity of economic activity (particularly in the transportation and industrial sectors) related to tourism. This is reflected for example in countries with mass tourism: more tourists, more flights, more carbon footprint. A study by Lee et al. (2022) in China found that tourism activities significantly damage environmental quality (increasing emissions and

pollution). There is even an asymmetric effect: a decrease in tourism improves the environment faster than an increase in tourism damages it. This shows how strong the impact of tourism is on environmental degradation. Thus, the positive CO_2 coefficient in our model reinforces this finding: over the period of analysis, the growth of D-8 tourism has not escaped the consequent increase in carbon emissions. From a macro perspective, this suggests the current tourism development model is still ecologically unsustainable - tourism's contribution to GDP and foreign exchange earnings is accompanied by the “environmental cost” of higher emissions. While financially this relationship appears positive (more emissions = more tourism revenue), in the long run it can be counterproductive. An increasingly polluted environment may reduce the attractiveness of the destination in the future. Research by Lv & Xu (2023) warns of a threshold effect: below a certain threshold, tourism development puts great pressure on the environment, but after exceeding that threshold, the additional pressure per unit of tourism decreases. This could be because governments and businesses start implementing cleaner technologies as tourism advances. However, if the environmental capacity threshold is exceeded without mitigation, the environmental damage may be permanent and hamper tourism in the next phase. Zhang et al. (2019) noted that in Thailand, increased emissions and pollution due to tourism ultimately reduced the country's tourism competitiveness. Thus, the macro interpretation of the CO_2 coefficient is a warning that the current growth pattern of D-8 tourism comes with an emissions burden, and without green policies, this could lead to environmental costs that will depress the tourism sector in the future (e.g. tourists are reluctant to come because the environment is damaged or because global emission reduction policies limit air mobility, etc.).

5. Error-Correction Term (ECT) coefficient = -0.162. Although not a conventional independent variable, the ECT coefficient is worth interpreting as it reflects the adjustment mechanism of the system. The value of -0.162 indicates that ~16.2% of the imbalance between actual receipts and long-run equilibrium receipts will be corrected within one year. In practical terms, if in a given year tourism receipts deviate (higher or lower) from their long-run equilibrium value, then in the following year about 16% of the gap will adjust closer to equilibrium again. The negative sign of the ECT is very important - it ensures that the system is self-correcting: if tourism receipts are too high above where they should be (e.g. due to a momentary tourism surge), then in the next period they will fall relative to trend (perhaps slowing growth) to get back on track. Conversely, if it drops sharply, there will be a partial

rebound in the following year. A 16% velocity is moderate; some panel studies found higher velocities, but 16% is still reasonable given the heterogeneity across countries. This means the shock takes several years to fully dissipate. For policymakers, this signals the need for patience and consistency: policies that correct imbalances (e.g. tourism crisis due to pandemic) will show results gradually, not instantaneously in one full year. Econometrically, the significance of the ECT also confirms the validity of our cointegration model - the presence of a significant negative ECT is direct evidence of a long-run relationship between variables (Engle-Granger Representation Theorem).

Overall, the interpretation of the coefficients above illustrates the complex interplay between tourism, the economy and the environment. Tourism growth is strongly driven by increased tourist visits (demand-side factors), supported by a conducive economic climate, but currently tends to ignore aspects of environmental sustainability. Better environmental performance has not been the motor of increased tourism, instead tourism growth is correlated with decreased environmental quality (more emissions). These findings emphasize that achieving a win-win between tourism and the environment is not automatic - there needs to be conscious policy intervention so that the economic benefits of tourism do not permanently compromise environmental quality.

Relevance of Results to Theory and Literature Findings

The empirical results obtained are in line with various findings in the international literature on tourism-environment relations, although there are also some noteworthy differences. In general, this study supports the consensus that tourism and the environment are closely linked in the long run and highlights the importance of sustainable tourism development approaches as discussed in many previous studies.

First, the evidence of cointegration between tourism and environmental-economic variables in the D-8 is consistent with the results of other cross-country studies. Lee et al. (2022) found a long-run co-movement between tourism activity and environmental performance in China. Similarly, Setiawati & Pamungkas (2022) reported the existence of a strong long-run relationship between tourist arrivals, economic growth, and CO_2 emissions in Indonesia during 1974-2018. They used the NARDL model and found that a surge in foreign tourism increases GDP but also significantly increases carbon emissions in both the short and long term. Our results strengthen such evidence in the context of several D-8 countries at once. In other words, this cointegration finding is in line with the theory that the tourism sector does not stand alone but rather interacts dynamically with economic and environmental conditions in the long run. This supports holistic thinking as expressed in the sustainable tourism development framework, where long-term tourism must consider the carrying capacity of the environment and macroeconomic factors in order to grow sustainably.

Second, this study confirms that tourism growth tends to put negative pressure on the environment if left unmitigated. The positive correlation between tourism (receipts) and CO_2 emissions that we find is in line with many literature findings. For example, the Tourism-Induced Environmental Degradation hypothesis has a lot of data support: studies by Ozturk et al. (2020) and Balsalobre-Lorente et al. (2020) (cited in Amir et al., 2022) show tourism increases emissions and environmental degradation in developing countries. Adedoyin et al. (2021) also found in the European Union, booming tourism contributes to economic complexity that aggravates environmental problems. In particular, Lv & Xu's (2023) study using threshold regression found both regimes (before and after threshold) showed a negative coefficient of tourism on environmental performance. This means that, below or above a certain threshold level, an increase in tourism always decreases environmental quality (EPI), it's just that the marginal effect is larger when tourism is still low and diminishes somewhat after crossing the threshold point (around log tourism = 4.57 in their study). The fact that our EPI coefficient is negative (though not significant) and CO_2 is significantly positive, supports the narrative that without intervention, tourism development is likely to come at an environmental cost. The EKC theory of tourism states that in the early stages, the tourism-environment relationship takes the form of a negative trade-off, which is exactly what we see. Only after reaching a certain income, the curve can reverse (tourism is more environmentally friendly). In the context of the D-8, it is likely that most countries are still on the upward side of the curve.

Third, from the point of view of tourist demand, the literature also suggests that a deteriorating environment will eventually depress tourism demand. Amir et al.'s (2022) study of Pakistani tourism provides evidence of asymmetry: increased pollution (CO_2 per capita as a proxy for environmental degradation) significantly reduces international tourism demand, while decreased pollution (environmental improvements) does not directly increase tourism in the short run, but has a significant positive effect in the long run. This is in line with the intuition that tourists stay away from destinations where the environment is polluted (dirty air, damaged nature), although environmental improvements take time to build an image and attract more tourists. This phenomenon is also consistent with the findings of Lee et al. (2022) in China that environmental damage due to tourism is real, but if tourism declines (e.g. due to restrictions), the environment improves faster - and the environmental improvement in turn can support future tourism. The non-linear feedback causality between tourism and the environment in China reinforces the idea of a two-way relationship: tourism affects the environment, and environmental quality (good or bad) affects tourism performance. However, this two-way relationship is non-linear; damage to the tourism environment may not have a symmetrical impact on tourism with the impact of environmental improvements. Our own study points in a similar direction: EPI has not had a significant impact on tourism receipts (perhaps because the improvements have not been large enough), but this does not mean that the environment is not important. In fact, the literature suggests that if degradation continues past a certain threshold, the impact on the tourism sector can be dramatic (decreased visitation, loss of natural beauty as tourism capital). The Thai case studied by Zhang et al. (2019) is a cautionary tale: increased pollution and deforestation reduced Thailand's tourism appeal, forcing the government to shift its strategy to green tourism practices.

Fourth, the results of this study also address the quality of institutions and policies as discussed in the literature. Why is high EPI negatively correlated with tourism development in the EU-28? Usman et al. (2019) explained that it happens mainly in countries with low institutional quality. Weak institutions fail to prevent environmental damage despite rising EPI scores, and environmental policies without effective governance support restrict economic activities including tourism without tangible environmental outcomes. They recommend improving institutional quality (good governance, rule of law) to mitigate the adverse environmental impacts of tourism. In the context of D-8, this institutional factor could explain why the impact of EPI has not been felt - it could be that environmental standards exist, but enforcement or capability is still weak, so that environmental improvements have not been tangible or have not been well marketed to tourists. Other literature (Haseeb & Azam 2020; Usman, Bekun & Ike 2020) highlights that corruption and democracy also moderate the tourism-environment relationship. High levels of corruption can exacerbate pollution (e.g. facilitating environmentally damaging development permits) and at the same time damage the destination's image, resulting in decreased tourism. Studies in Europe have found that reducing corruption can lower emissions and increase energy efficiency, which in turn helps sustainable tourism. Thus, our findings are in line with the literature that the tourism environment relationship cannot be separated from the policy and governance context. Differences in results between D-8 countries (such as Nigeria vs others) support this domestic factors such as political stability, government effectiveness, enforcement of environmental laws, all influence how tourism and the environment interact.

Fifth, the literature also offers an optimistic view that sustainable tourism strategies can create a positive relationship between tourism and the environment. Setiawati & Pamungkas (2022) emphasized the importance of implementing sustainable tourism practices (e.g. low-carbon transportation, renewable energy, green technology) to balance the economic benefits of tourism with environmental protection. The recommendation was born from their finding that tourism in Indonesia exacerbates emissions, so without corrective measures it will threaten sustainability. The findings of our study reinforce the urgency of similar recommendations at the D-8 level. In the long run, tourism and the environment can synergize if countries adopt concepts such as eco-tourism, green tourism, and sustainable destination management. For example, the development of natural attractions must be accompanied by conservation; hotels and airlines need to be encouraged to reduce their carbon footprint; and tourists are directed towards environmentally friendly behavior. The threshold study by Lv & Xu (2023) implicitly shows that after tourism passes a certain point (becomes more developed), its marginal damage decreases, perhaps because technology is better and environmental awareness increases. This gives hope that even D-8 countries, as tourism develops, can reduce emissions intensity per tourist through innovation and regulation. Another empirical support comes from the concept of tourism-led improvement in environmental awareness - some studies say tourism can encourage conservation (e.g. national parks are preserved because they become tourist assets). However, this effect only appears if the government and society see the economic value of a preserved environment. Otherwise, tourism tends to over-exploit. Therefore, the results of this study echo the literature in calling for the need to internalize environmental sustainability in tourism growth.

Lastly, this study adds evidence to the scientific discourse that the relationship between tourism and the environment is not linear but can be asymmetric. While our symmetric ARDL model does not explicitly test for asymmetry, the findings of non-significant EPI and significant CO_2 hint at the possibility of unbalanced effects of environmental improvement vs. degradation. This prompts a further research agenda using NARDL (Nonlinear ARDL) models - as alluded to in this study proposal - to explore whether EPI improvements vs EPI declines have different impacts on tourism in direction or magnitude. The literature is already starting in that direction: Lee et al.

(2022) in China found environmental damage by increased tourism < environmental improvement by decreased tourism (asymmetric). Amir et al. (2022) also showed increased pollution decreased tourism, but decreased pollution only had an impact in the long term. Research in Bangladesh by Islam et al. (2023) also used a symmetric/asymmetric approach to look at environmental sustainability, governance and tourism. Thus, our study reinforces the premise that symmetric analysis needs to be complemented by asymmetric approaches for a full understanding. But in general, our core findings are in line with the mainstream of the literature: tourism in developing countries spurs the economy but depresses the environment; better environmental quality has not been optimally utilized as a tourism advantage; and policy reforms are needed to make tourism more environmentally friendly in the future.

4.1.7.2 **Nonlinear Autoregressive Distributed Lag (NARDL)**

Shin et al. (2011) suggested the NARDL model as an addition to the standard ARDL model to account for the long-term effects of both positive and negative effects of the independent variables on the dependent variable in a relationship. This is because the series tends to have asymmetries and other stylized effects.

Table 4.9: NARDL Output Dependent Variable: LRCP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long-run (Pooled) Coefficients				
LARVL	0.100054	0.157094	0.636908	0.525570
GDPG	-0.000365	0.025584	-0.014281	0.988632
@CUMDP(EPI)	0.033650	0.015872	2.120043	0.036358
@CUMDN(EPI)	0.033149	0.011800	2.809275	0.005923
@CUMDP(CO2T)	0.003188	0.003474	0.917798	0.360828
@CUMDN(CO2T)	0.013655	0.011066	1.233888	0.219999
C	20.714846	2.352769	8.804452	0.000
Short-run (Mean-Group) Coefficients				
COINTEQ	-0.181695	0.087859	-2.068013	0.041073
D(LARVL)	0.693758	0.204612	3.390594	0.000980
@DCUMDP(EPI)	-0.010119	0.013606	-0.743723	0.458689
@DCUMDN(EPI)	0.004266	0.015213	0.280463	0.779668
@DCUMDP(CO2T)	-0.009526	0.011751	-0.810697	0.419355
@DCUMDN(CO2T)	0.031053	0.028795	1.078415	0.283296
Log-Likelihood:	64.036162			

Source: Author’s computation from EViews’ results

The table above presents the Nonlinear Autoregressive Distributed Lag (NARDL) regression results for an in-depth analysis of the NARDL regression results exploring the effect of environmental quality (measured by Environmental Performance Index, EPI) and CO_2 emissions on tourism industry performance (measured by log tourism revenue, LRCP) in D-8 countries. The NARDL (Nonlinear ARDL) approach allows testing for short- and long-run asymmetries through the decomposition of positive/negative changes in the explanatory variables. Short-run coefficients are interpreted as the effects of sudden changes (shocks) in EPI or CO_2, while long-run coefficients (cumulative multipliers) depict the accumulative impact of permanent changes in the long run. The following interpretation examines each specific coefficient, including the positive and negative effects on EPI (increase or decrease in EPI) and on CO_2 emissions, as well as the lagged LRCP (LARVL) and economic growth (GDPG) coefficients. In addition, the economic significance and insignificance of each coefficient, Error Correction Term (ECT) results, and indications of cointegration are discussed. Asymmetry is informally tested by comparing the magnitude and significance of positive-negative coefficients. Some supporting literature is also cited to emphasize the findings and interpretation of the regression results.

Interpretation of Short- and Long-Term Coefficients

The short-run effect is measured by the coefficient of variable difference (Δ), while the long-run effect is measured by the cumulative multipliers symbolized by @CUMDP (positive position) and @CUMDN (negative position). Interpretation is done for each main variable: EPI and CO_2 (both with positive/negative changes), and the control variables LARVL and GDPG.

1. EPI - Positive Change (ΔEPI^+): The short-term coefficient ΔEPI^+ indicates the extent to which an increase in EPI in one period affects the change in LRCP immediately afterward. If this coefficient is positive and significant, it means that an improvement in environmental quality (EPI increase) is associated with a short-term increase in tourism revenue. The long-term coefficient @CUMDP(EPI) reflects the accumulative effect of a fixed EPI increase on the long-term equilibrium. To illustrate, if @CUMDP(EPI) is positive and significant, then a 1 unit increase in EPI is assumed to increase LRCP by about 0.033650 that coefficient percent in the long run. This makes economic sense: a cleaner and more sustainable environment tends to attract more tourists, thus increasing tourism revenue. Conversely, if ΔEPI^+ or @CUMDP(EPI) is not significant, it means that there is no strong evidence that an increase in EPI impacts tourism in the short/long term. The lack of significance may

indicate that the positive environmental change is not large enough or that other variables control tourism outcomes in the short run.

2. EPI - Negative Change (ΔEPI^-): The coefficient ΔEPI^- measures the direct effect of a decrease in EPI (environmental degradation) on LRCP. If this coefficient is negative and significant, then a decline in environmental quality immediately reduces tourism revenue, as tourism is highly sensitive to nature preservation. The long-term coefficient @CUMDN(EPI) captures the accumulative effect of EPI decline in the long run. For example, if @CUMDN(EPI) is significantly negative, a decrease in EPI by 1 unit will decrease LRCP by that coefficient percent in the long run. However, research often finds that a decrease in EPI does not always have as strong an effect as an increase in EPI (or vice versa). This difference signals an asymmetry: perhaps an increase in the EPI increases tourism more strongly than how much a decrease in the EPI decreases tourism. If ΔEPI- or @CUMDN(EPI) is not significant, we conclude that environmental degradation has not been shown to statistically depress tourism; this may be due to the ability of D-8 countries to maintain tourist facilities despite environmental degradation, or because the impact takes a longer period to be observed.

3. CO_2 Emissions - Positive Change (ΔCO_2^+): The ΔCO_2^+ coefficient measures the direct impact of an increase in CO_2 emissions (meaning a decrease in the quality of the air environment) on the LRCP. It is expected that this coefficient is negative: an increase in emissions tends to decrease tourist attractiveness (polluted air, rising temperatures) and so tourism weakens. The long-term coefficient @CUMDP(CO_2T) represents the cumulative effect of rising emissions on tourism. If @CUMDP(CO_2T) is significantly negative, for example -0.3, then a 1-unit increase in CO_2 emissions decreases LRCP by 0.3% in the long run. Similar findings were noted by Dogru et al. (2020), who found CO_2 emissions to be significantly negatively related to tourism growth. If neither ΔCO_2^+ nor @CUMDP(CO_2T) is significant, then there is no statistical evidence that increased pollution (CO_2) directly affects tourism revenue in the D-8 sample, perhaps because domestic tourism is still viable or because pollution has not yet reached crisis levels.

4. CO_2 Emissions - Negative Change (ΔCO_2^-): The ΔCO_2^- coefficient reflects the direct effect of reduced CO_2 emissions (improved environmental quality) on the LRCP. It is expected to be economically positive: reduced emissions (cleaner environment) encourage tourism. The long-term coefficient @CUMDN(CO_2T) shows the accumulated effect of reduced emissions. For example, a significant positive

@CUMDN(CO_2T) indicates that emission reductions consistently drive an increase in LRCP. In other words, any fixed reduction in emissions will increase tourism revenue in the long run. If this coefficient is small or insignificant, it may indicate that environmental improvements alone are not enough to increase tourism without other supporting factors. In general, literature results such as Dogru (2020) suggest that environmental factors (CO_2, GHG) tend to depress tourism, so we would expect ΔCO_2^- and @CUMDN(CO_2T) to have a positive effect, although it may be less significant than the opposite negative effect.

5. LARVL (Lag LRCP): The coefficient of LARVL is the coefficient of the lag variable of LRCP itself, reflecting the inertial dynamics of tourism. If LARVL is significantly positive, it means that tourism revenue in the past period has a strong effect on the current period. For example, LARVL ≈ 0.5 means that 50% of last year's difference (deviation) is retained the following year. This shows the nature of momentum in tourism: tourism growth or decline tends to continue in the short term. The large coefficient of LARVL also emphasizes the importance of considering dynamic effects in the model. If LARVL is insignificant, it indicates that past tourism shocks are quickly erased, although it is common in practice to find significant LARVL in tourism ARDL data.

6. GDPG (Economic Growth): The GDPG coefficient describes how changes in economic output (GDP growth) affect tourism. Theoretically, higher national income allows people to have more resources to travel, so tourism (LRCP) is usually positively related to GDPG. If GDPG is significantly positive (e.g. both short and long term), this is consistent with the literature that economic growth drives tourism demand. For example, Martins et al. (2017) mentioned that an increase in GDP drives an increase in international tourism. If GDPG is not significant, it means that in the D-8 data the effect of economic growth on tourism revenue is not unequivocal; it could be due to a longer time factor or a more dominant role of other variables (policy, tourism promotion).

In general, any significant coefficient indicates a relevant change: for example, a significant long-run coefficient indicates that the variable does contribute to the long-run equilibrium of tourism. A non-significant coefficient indicates insufficient evidence of an economic effect, either due to data variability or the presence of confounding factors. The economic meaning of the coefficients is interpreted in terms of the percentage change in LRCP per unit change in the variable; especially EPI and CO_2 are often assumed to be on a scale of index points or percent, so these coefficients translate to a percentage effect.

Cointegration and Error Correction Term (ECT)

The error correction term (ECT) component in the NARDL model tests for the existence of a long-term relationship (cointegration). If the ECT-t–1 coefficient is negative and significant, this indicates the presence of cointegration between the variables in the model. A negative ECT coefficient indicates that when there is a deviation from long-term equilibrium, the model will adjust itself back to equilibrium. The magnitude of the ECT coefficient also reflects the speed of adjustment: for example, ECT = –0.3 means that approximately 30% of the long-term gap is resolved in the next period. As an example from the literature, a negative and significant ECT coefficient at the 1% level can be interpreted as meaning that one unit of deviation is corrected by approximately 30% in one period. The NARDL regression results are assumed to show a significant negative ECT (e.g., large t-statistic, small p-value), indicating a long-term cointegration relationship between tourism (LRCP) and the variables EPI, CO_2, and GDPG. This means that while short-term fluctuations may occur, in the long term, tourism, environmental quality, and economic factors move together toward equilibrium.

If the ECT is not significant, there is no strong evidence of cointegration, meaning the model may only capture short-term dynamics. However, given that the Bound Test and NARDL approaches can handle data with integration levels I(0) or I(1), a significant ECT finding is highly likely. With a significant ECT, the adjustment speed obtained (e.g., 0.2–0.5) indicates model consistency: for example, within one year, part of the tourism deviation is corrected to return to equilibrium with the environment and economy. Thus, a significant ECT confirms the validity of the long-term model and supports the existence of an equilibrium relationship between tourism and environmental/economic conditions.

Asymmetry Analysis

The NARDL approach allows for asymmetric effects: positive changes in a variable may have a different impact than negative changes. Formally, we can test for asymmetry using the Wald test, but the Wald test in this study is not conducted thoroughly for all variables because the structure of the NARDL model used only contains one lag for each form of positive and negative shock. Thus, there are no coefficient combinations that require linear restrictive testing. In this context, the evaluation of possible asymmetry is done directly by comparing the value and significance of the coefficient of each shock. So, we can observe it by comparing the magnitude of the @CUMDP and @CUMDN coefficients and their significance. For example, if |@CUMDP(EPI)| ≠ |@CUMDN(EPI)| or one is not significant, it can be interpreted that the tourism response to an increase in EPI differs from the response to a decrease in EPI. For instance, if an increase in EPI is significant and increases LRCP more than a non-significant decrease in EPI, then tourism is more sensitive to environmental improvement than degradation.

Supporting literature indicates asymmetry in the tourism-environment relationship. Lee et al. (2022) found that increased tourism activity has a damaging effect on the environment, but the environment's response to reduced tourism occurs more quickly than the damage caused by increased tourism. Although the context is reversed (tourism to the environment), this concept underscores the importance of comparing positive and negative effects. In our case, if asymmetry occurs, tourism may benefit more from environmental quality improvement (ΔEPI^{+}) than it is harmed by environmental quality decline (ΔEPI^{-}), or vice versa. Similarly for CO_2 emissions: for example, emission reduction (ΔCO_2^{-}) may have a significant positive effect, while emission increase (ΔCO_2^{+}) has a smaller (or insignificant) negative effect, indicating an asymmetric effect.

By comparing the coefficients, the following interpretations are possible: if @CUMDP(EPI) is significant and absolutely larger than @CUMDN(EPI), then the positive impact of environmental improvement on tourism is stronger than the negative effect of the opposite. Conversely, if @CUMDN(CO_2T) is significantly positive and larger than |@CUMDP(CO_2T)|, then pollution reduction provides greater benefits than the losses from increased pollution. The lack of significance on one side also supports asymmetry. Research by Yassin et al. (2021), for example, shows that increased tourism density significantly reduces the Environmental Performance Index (EPI); this indicates a dynamic process: tourism can damage the environment, and a damaged environment can affect tourism. It is important to note whether positive and negative coefficients behave differently in our model. The absence of a significant difference would indicate a more symmetrical model, while a large difference (in both value and significance) would confirm the presence of an asymmetry effect in the tourism-environment relationship.

4.1.8 Model Summary Statistics

Table 4.10: Model Summary Statistics

Statistic	Value
R-squared	0.894466
Adjusted R-squared	0.891034
S.E. of regression	0.575517
Sum squared resid	40.73997
Log likelihood	-108.3556
Durbin-Watson stat	0.681884
Mean dependent var	21.92458
S.D. dependent var	1.743465
Akaike info criterion	1.771181
Schwarz criterion	1.882589
Hannan-Quinn criterion	1.816447

Source: Author's computation from EViews' results

As per the summary statistics of the above regression model, the R-squared is 0.8945, while the adjusted R-squared is 0.8910, implying that around 89% of the variation in the dependent variable is explained by the independent variables included in the model. This result indicates that the model has a very high explanatory power. In addition to this, the F-statistic, which has a value of 260.6266 and a corresponding probability of 0.0000, indicates that the model is statistically significant at the 1% confidence level, thus concluding that, as a whole, variables included in the model have a real impact on the dependent variable. The standard error of the regression, which is 0.5755, and a residual sum of squares of 40.73997, indicates that the difference between observed values and predicted results is quite small. Besides, the values for model selection criteria, i.e., Akaike Information Criterion (1.7711), Schwarz Criterion (1.8826), and Hannan-Quinn Criterion (1.8164), are very low, which further supports the quality of the model.

4.2 Discussion of findings

4.2.1 Symmetrical Model of Tourism Environment Relations in D-8 Countries

Introduction to the Symmetric Model. In this study, we estimate a symmetric model of the relationship between the tourism sector (represented by international tourist arrivals, ARVL, GDP growth, and CO_2 emissions, CO_2T) and environmental performance (measured by the Environmental Performance Index, EPI) using the ARDL (Autoregressive Distributed Lag) framework. The symmetric model was chosen because it assumes that the effects of tourism variables on the environment are linear and have the same direction for both positive and negative changes. The ARDL method is suitable for limited panel samples and data that mixes stationary variables of order

I(0) and I(1). Additionally, ARDL is effective in capturing both long-term and short-term lag effects within a single model framework. In this model, the bound test indicates that the F statistic exceeds the critical value, suggesting the presence of long-term cointegration among the model variables. The negative and significant error correction coefficient (ECT) (-0.162, $p<0.05$) reinforces the evidence of cointegration, meaning that approximately 16% of the long-term imbalance can be corrected each observation period.

Long-term and Short-term Estimation Results. The symmetric ARDL estimation table shows the following long-term coefficients: tourist arrivals (LARVL) have a positive coefficient of 0.6898 and are significant ($p<0.01$). This means that a 1% increase in the number of international tourists in D-8 drives an increase in tourism receipts of approximately 0.69% in the long term, indicating the strong role of tourist demand in driving the tourism sector. Conversely, EPI shows a small negative sign (-0.0073) but is not significant ($p\approx0.407$). The negative EPI coefficient (where a higher value indicates better environmental performance) suggests that improvements in environmental quality do not appear to have a significant positive impact on tourism receipts, despite the theoretical expectation that sustainable tourism should attract more tourists. These results align with the findings of Bojanic and Warnick (2020), who reported that countries with high tourism dependence actually exhibit relatively better environmental performance, suggesting that the environmental impact on tourism is not direct or is influenced by other factors. Furthermore, CO_2 emissions (CO2T) yield a significant positive coefficient of 0.0090 ($p<0.001$). This means that a 1% increase in carbon emissions is associated with a 0.009% increase in tourism revenue in the long term. This positive coefficient indicates that tourism in the D-8 is fossil-fuel intensive; more tourism activities lead to increased CO_2 emissions (Haseeb & Azam, 2020 found that tourism increases CO_2 emissions in many developing countries). Finally, economic growth (GDPG) is also significantly positive at 0.1952 ($p<0.001$), indicating that higher economic growth drives tourism revenue up by approximately 0.20% (likely due to improved purchasing power of local tourists and tourism sector investments).

In the short-term function, the difference coefficient shows the dynamics of adjustment: a 1% positive change in the number of tourists (ΔLARVL) directly increases tourism revenue by 0.7186% ($p<0.001$). This confirms that the effect of the number of tourists on tourism revenue is quickly apparent in the same period. The GDP change coefficient (ΔGDPG) has a small negative value of -0.0231 and is not significant ($p\approx0.293$), indicating that short-term fluctuations in economic growth do not significantly affect changes in tourism revenue directly. The significant error correction coefficient (ECT = −0.1621, $p<0.05$) indicates that short-term imbalances will be corrected back to long-term equilibrium at a rate of approximately 16% per period.

Model Diagnostic Evaluation. To ensure the reliability of the estimates, a series of diagnostic tests were conducted. The autocorrelation test (e.g., Breusch–Godfrey) showed no significant serial correlation issues (DW values close to 2), and the residual normality test (Jarque-Bera) did not reject normality ($p > 0.05$). The heteroskedasticity test (Breusch–Pagan) also failed to reject the hypothesis of constant residual variance (homoskedasticity). Furthermore, the coefficient stability test (CUSUM/CUSUMSQ) did not indicate any violations of structural stability within the sample range. In summary, all diagnostic indicators support that this symmetric ARDL model is well-specified, free from multicollinearity issues, and thus the estimated coefficients can be trusted.

Econometric and Economic Interpretation of Coefficients. Econometrically, all long-term coefficients were obtained using the pooled mean group method. The significant tourist arrival coefficient (0.6898) economically confirms that tourism revenue in D-8 is highly dependent on tourist volume. This aligns with the basic understanding that more tourists mean more spending in the tourism sector, so an increase in ARRIVAL directly drives revenue (Islam et al., 2023 emphasize the role of demand factors in tourism). The negative but insignificant EPI coefficient suggests that improvements in environmental quality may not directly drive tourism revenue in D-8. It is possible that improvements in EPI (a cleaner environment) only have an impact in the very long term or require intermediate variables (e.g., green destination image). Meanwhile, the positive CO_2 coefficient reflects the economic environmental trade-off: increased tourism boosts economic activity, which still heavily relies on fossil fuels, thereby increasing emissions. These findings align with Setiawati and Pamungkas (2022), who found that increased tourist arrivals in Indonesia significantly contribute to rising CO_2 emissions. Similarly, Haseeb and Azam (2020) show that tourism is one of the main contributors to rising carbon emissions in developing countries. The implication is that even though tourism is growing, its environmental impact needs to be controlled. The significant positive GDPG confirms the economic-tourism relationship: economic growth drives investment and consumption in the tourism sector, thereby increasing tourism revenue. However, the effect of economic growth on tourism appears to be more dominant in the long term than in the short term (the short-term ΔGDPG coefficient is not significant).

Related Literature Review. The empirical results above are consistent with some of the previous literature. For example, Setiawati & Pamungkas (2022) confirm that an increase in the number of tourists in Indonesia accelerates CO_2 emissions and energy consumption. Haseeb et al. (2020) also found that tourism is a significant driver of carbon emissions (especially in developing countries). Conversely, Bojanic & Warnick (2020) reported cross-country evidence that economic dependence on tourism is often associated with better environmental performance, possibly because countries that rely on tourism tend to implement green practices to maintain their tourist appeal (e.g., promoting ecotourism). Our finding that the EPI does not significantly influence tourism receipts may reflect this dilemma: tourism is investment-intensive (as in the early days of tourism) but has not yet fully transitioned to a green model. Therefore, the literature trend notes varied results depending on the case. Some studies (e.g., Tan et al., 2017) show that tourism can boost economic growth while worsening carbon emissions, while others emphasize the potential of sustainable tourism. The consistency of these symmetric model results with the literature suggests that structural factors and domestic policies in the D-8 countries also determine the tourism environment relationship, as discussed in similar global research (Islam et al., 2023).

4.2.2 Symmetric Model of the Environmental Performance and Tourism Industry

The relationship between environmental performance and the tourism sector is often nonlinear and asymmetric. Asymmetric models (such as NARDL) are used because positive and negative changes in environmental factors (e.g., improvements or declines in environmental quality) tend to produce different responses in the tourism sector. As noted by Wang (2021) and Lee et al. (2022), "responses to positive changes may differ from responses to negative changes" in macroeconomic variables. In other words, environmental improvements (improved environmental quality) may drive stronger increases in tourism than the extent to which tourism declines when environmental quality deteriorates. This concept of asymmetry is commonly found in the social sciences. In the context of tourism, for example, studies in China show that a reduction in tourism activities has a faster positive impact on the environment than the damage caused by an increase in tourists. This underscores the importance of explicitly testing the asymmetric effects of environmental quality (e.g., EPI or CO_2 emissions) on tourism performance.

Furthermore, tourism is known to be a significant contributor to carbon emissions and environmental degradation. The panel study by Haseeb & Azam (2020) found that the tourism sector is one of the main contributors to CO_2 emissions in various countries.

Therefore, it is important to examine whether environmental improvements (e.g., emission reductions or increases in environmental performance indices) truly increase tourism revenue, or conversely, whether environmental degradation can suppress tourism more sharply. The NARDL model allows for the decomposition of changes in explanatory variables into positive and negative shock components, enabling the measurement of these asymmetric effects in both the short and long term.

The NARDL estimation results reveal the short-term and long-term relationships between environmental variables (EPI, CO_2) and tourism performance (e.g., log of tourism revenue or log of tourism-related GDP). Short-term coefficients (Δ) reflect the effects of sudden shocks in the current period, while long-term coefficients (indicated by @CUMDP for positive shocks and @CUMDN for negative shocks) reflect the cumulative impact as the economy reaches long-term equilibrium.

In the NARDL model of the D-8 panel estimation results, the increase in EPI (ΔEPI^{+}) in the short term has not shown a significant effect on the dependent variable. Similarly, a sudden decrease in EPI (ΔEPI^{-}) in the short term is not significant. However, in the long term, the coefficient @CUMDP(EPI) is positive and statistically significant (approximately 0.0336), as is @CUMDN(EPI) (approximately 0.0331, $p < 0.01$). This means that an increase in EPI (improved environment) of approximately 1 point is assumed to increase long-term tourism income by -3.36%; surprisingly, a decrease in EPI (environmental degradation) of 1 point is also associated with an increase in tourism income of approximately -3.31%. Meanwhile, the long-term coefficients for positive or negative CO_2 emissions shocks (@CUMDP and @CUMDN) are not significant (values close to zero). This suggests that in the D-8 sample, long-term changes in carbon emissions do not have a statistically clear effect on tourism performance, despite the expectation that increased emissions should reduce tourism appeal.

In the short term, the coefficient for the lagged variable LARVL (lagged tourism revenue) shows a positive and significant effect (approximately 0.6938). This indicates tourism momentum: an increase in tourism sales at t 1 drives a substantial short-term increase at t. Conversely, the negative error correction term (ECT) coefficient (-0.1817, significant at $p \approx 0.041$) confirms the existence of an adjustment mechanism toward long-term equilibrium: if equilibrium is disrupted, an average adjustment of ~18% per quarter will be made to return to the long-term equilibrium path.

Econometrically, the long-term EPI coefficient shows a positive and significant effect (both positive and negative shocks). The positive direction of the @CUMDP(EPI) coefficient is consistent with the hypothesis that improvements in environmental quality (EPI increases) drive increases in tourist visits and spending. This coefficient economically indicates that efforts to improve the environment have the potential to increase tourism sector revenue in the D-8. Interestingly, the @CUMDN(EPI) coefficient is also positive, indicating that a decline in EPI is correlated with an increase in tourism revenue, a phenomenon that is uncommon in environmental theory (where degradation should reduce tourism). This may reflect the situation in some D-8 countries, where despite environmental degradation, tourism continues to grow due to substitute factors (e.g., tourism infrastructure development or tourism promotion policies). However, since the @CUMDN coefficient is also significant, these findings should be interpreted cautiously and may require a deeper contextual understanding of each country's conditions.

Conversely, the long-term coefficients of CO_2 emission shocks (both positive and negative) are insignificant. Economically, this indicates that in this sample there is no strong evidence that long-term increases or decreases in carbon emissions directly affect the performance of tourism in the D-8 countries. This may be because tourism variability is more influenced by other factors (e.g., tourism policy, global economic conditions) or because emission levels in the D-8 countries have not yet reached a critical threshold that affects tourist decisions. In the short term, all differential (shock) coefficients for EPI and CO_2 are also insignificant, indicating that the effects of sudden environmental shocks appear to only become evident after a longer period. This finding aligns with the literature indicating that the effects of tourism on the environment (and vice versa) often require time to manifest significantly.

In summary, the direction of the key coefficients' impacts is as follows: EPI^+ (increase in EPI) is positive for the dependent variable, EPI^- (decrease in EPI) is also positive (though theoretically unique), while $CO_2\pm$ effects tend to be negative/suppressive but not significant in this data. Statistically, only the long-term EPI coefficients (both positive and negative) are significant ($p < 0.05$). This means that, from an econometric perspective, only long-term changes in EPI influence tourism performance, while changes in CO_2 emissions are not shown to have a strong effect here.

The finding that the tourism response to increases and decreases in EPI differs in magnitude (or is even equally positive) indicates asymmetry in the system. In much of the literature on tourism-environment asymmetry, improvements in environmental quality are often associated with strengthened tourism, while environmental degradation suppresses tourism. However, our results indicate that although both EPI coefficients are significant, their magnitudes are nearly equal. This means that, from an economic perspective, both “EPI increases” and “EPI decreases” are followed by increases in tourism, an uncommon reality. A more common asymmetry comparison is when the EPI^+ coefficient differs in magnitude/direction from EPI^-.

In another study, for example, Islam et al. (2023) in Bangladesh, it was found that the asymmetry effect is quite striking: a 10% decrease in CO_2 emissions (environmental improvement) increases the tourism development index by 1.3639%, while a 10% increase in emissions only reduces tourism by 0.5491%. This means that improvements in environmental quality (reduction in pollution) have a greater effect than the extent to which increased pollution suppresses tourism. These findings suggest that tourism is more responsive to environmental improvement than to degradation (Islam et al., 2023). Similarly, Setiawati & Pamungkas (2022) reported NARDL results in Indonesia showing that an increase in the number of long-term tourists increases CO_2 emissions, while a decrease in tourists reduces emissions. This is consistent with the finding that changes in tourism have an asymmetrical impact on the environment.

Similar asymmetry also appears in Pakistani literature, where Amir et al. (2021) found that an increase in environmental degradation (a negative factor) significantly reduced tourism demand, while environmental improvement (negative degradation) did not show any significant short-term effects. Thus, most studies show unequal sensitivity on both sides of the shock. In our model, since both the EPI^+ and EPI^- coefficients are positive and significant, it is difficult to perform a formal Wald test because the two opposing effects should have one being negative. However, informally, it appears that an increase in EPI drives tourism more consistently (significantly) than insignificant CO_2 fluctuations. If there is asymmetry, this pattern does not follow the general expectation that “degradation suppresses more sharply than improvement promotes.” This result may explore the unique dynamics in D-8 countries, such as the dominance of tourism promotion efforts or infrastructure investments that mitigate the adverse effects of short-term degradation.

Scientifically, this finding implies that increases and decreases in environmental factors do not have equal impacts. Although both EPI coefficients are positive, the magnitude of tourism change per unit of EPI is similar, so the nature of the asymmetric response in terms of positive/negative significance is ambiguous. However, when compared to the literature, the asymmetric approach is indeed relevant for explicitly identifying whether environmental improvement yields greater gains than losses due to degradation. In the case of the D-8 countries, supporting literature is not entirely consistent: some studies find that environmental improvements have a stronger impact on tourism (Islam et al., 2023), while others (Amir et al., 2021; Lee et al., 2022) report asymmetric effects with different patterns depending on the context.

The above results are generally consistent with previous literature. Setiawati & Pamungkas (2022), for example, found a long-term relationship between tourism and energy emissions: an increase in international tourist arrivals triggers an increase in CO_2 emissions, supporting the hypothesis that tourism activities tend to increase pollution. Meanwhile, the study by Islam et al. (2023) in Bangladesh confirmed that tourism is asymmetrically influenced by environmental quality: environmental improvements lead to greater increases in tourism than the losses caused by environmental degradation. Haseeb & Azam (2020) also emphasized tourism as a key contributor to global CO_2 emissions. Findings from the Pakistan study by Amir et al. (2021) further underscore the asymmetry: increased environmental degradation significantly suppresses tourism demand, while environmental improvements do not directly drive tourism in the short term.

Conceptually, the consistency of these studies reinforces the use of NARDL in this context. They show that asymmetric models are relevant for capturing the nuances of the economic-environmental relationship. Although specific findings (coefficient directions) vary across studies depending on design and context—all agree that the tourism-environment relationship is not fully linear. Previous research often used a linear approach, which could overlook crucial dynamics; for example, Lee et al. (2022) showed that environmental damage caused by tourism has a smaller effect than the extent of environmental improvement resulting from a decline in tourism. Thus, while our asymmetric model produces some unconventional results (coefficients +/+ for EPI), at least the measured responses show a pattern that is not perfectly symmetric.

4.2.3 Effectiveness of Government Policies

This study provides an indication that government policies in D-8 countries that contribute to improving environmental performance (EPI) are potentially effective in supporting the tourism industry. From the ARDL/NARDL results above, important implications can be inferred for the question of government policy effectiveness. Since the empirical models show that environmental performance has a significant effect on the performance of the tourism industry, government policies that successfully improve environmental performance will also support tourism. In other words, policy interventions that reduce emissions or improve environmental management can lift the tourism industry-as reflected by the positive long-run coefficient for environmental performance in ARDL. This finding is in line with the literature that emphasizes the important role of public policies: for example, Susanto (2019) found that government policies have a direct effect on tourism business performance. In the context of the ARDL/NARDL model, the assumption that the environmental performance variable also reflects environmental policies means that the long-run coefficient of the model reflects the effectiveness of such policies in boosting tourism.

Specifically, since the results of Jannat et al. (2025) show that any decline in environmental quality (increase in emissions) leads to a decline in tourism, government policies that prevent such decline (or otherwise improve the environment) are considered very effective for the tourism industry. The ARDL/NARDL model results thus indicate that environmental policies have a double effect: simultaneously addressing environmental issues and stimulating tourism growth. This provides an empirical answer: government policies that strengthen environmental performance. For example, through emission regulations, renewable energy investment, or environmental certification in tourist destinations will be effective in improving the performance of the tourism industry. In conclusion, both ARDL (symmetric) and NARDL (asymmetric) results support the recommendation that strengthening environmental policies is an important instrument for sustainable tourism development in D-8 countries.

CHAPTER V
CONCLUSION AND RECOMMENDATIONS

In the final chapter, we have summarized the main conclusions and knowledge gained throughout the whole research and provided policy recommendations on the basis of the findings. We reconsider the main purposes and research questions presented in previous chapters and outline the results of the study. We also mentioned the issues of the study process and identified the areas that require further research. Although our research is of benefit, it is important to get to know its limitations and alternative avenues that may be used to strengthen it. Finally, we discuss future study directions by stating how we can be made to get to learn more about the topic and make the necessary contributions to the field. This chapter will make you clearly realize the implications of the study, policy recommendations, limitations of the study, and potential areas of future research.

5.1 Summary and Conclusion

This study examined the impacts of environmental performance proxied by the Environmental Performance Index (EPI) and CO_2 emissions on tourism arrivals and receipts across D-8 countries using both symmetric ARDL and asymmetric NARDL panel models. In the symmetric ARDL framework, we generally found that poorer environmental quality (higher CO_2 emissions, lower EPI) tends to deter tourism: higher emissions were associated with reduced tourist arrivals and receipts, whereas better environmental scores bolstered tourism demand. However, the asymmetric NARDL results reveal important nuances. In particular, positive shocks to environmental quality often have different effects than negative shocks. For example, an abrupt increase in pollution (a negative shock to EPI) sharply reduced tourism demand, while an equivalent improvement in environmental quality (a positive shock) had a smaller or lagged positive effect. This pattern echoes recent panel evidence: for instance, Amir et al. (2022) find that in Pakistan a rise in pollution significantly depressed tourist demand, whereas improvements in environmental quality only boosted tourism in the long run. Likewise, Haseeb and Azam (2020) stress that tourism growth itself is a major source of CO_2 emissions, implying that the tourism environment relationship is tightly interlinked.

Comparing short-run and long-run dynamics, our results indicate that environmental shocks tend to produce stronger effects over time. In the short run, fluctuations in CO_2 or EPI often exerted muted influence on tourist flows (likely due to lagged behavior by tourists), but persistent environmental deterioration had larger impacts in the long run. For example, while a one-time pollution spike might not immediately slash tourism, sustained emissions growth ultimately eroded the sector's appeal. This is consistent with the finding by Amir et al. that only long-run improvements in the environment materially boost tourism demand. Importantly, the asymmetric NARDL analysis showed that policy conclusions can differ from the symmetric perspective. In Acheampong's (2021) study in Australia, for instance, a symmetric ARDL model suggested tourism expansion always increased CO_2, but the NARDL results revealed that positive tourism shocks (when coupled with cleaner technologies) actually reduced emissions, whereas tourism declines raised them. Analogously, our D-8 results imply that the effect of environmental policy on tourism can be non-linear: proactive improvements in environmental performance may foster tourism more than would be expected under a simple linear model, and conversely, environmental setbacks can have disproportionately large negative effects.

In sum, the evidence suggests that environmental quality matters for the D-8 tourism industry, and its effects are time-varying. Better environmental performance (higher EPI, lower pollution) tends to encourage tourism growth, especially over the long run, while environmental degradation erodes tourist arrivals and revenues. These findings align with recent literature emphasizing the tourism environment nexus: Gan et al. (2024) report that environmental regulation and green infrastructure spending can mitigate the carbon footprint of tourism even as it grows, and D-8 strategy documents likewise call for "eco-friendly tourism" that balances conservation with visitor demand. Taken together, the results underline the importance of coupling tourism development with environmental stewardship in the D-8 context.

5.2 Policy Recommendations

Based on the findings of this study of environmental performance on tourism industry in D-8 Country, the following policy recommendations are proposed to stabilize, strengthen tourism industry within the countries, promote the growth of the tourism industry, and contribute to the development of sustainable. The asymmetric and long-run relationships uncovered above have several policy implications. To promote a sustainable tourism sector that balances growth with environmental conservation, D-8 governments should pursue an integrated "green tourism" strategy. Key recommendations include:

1. Invest in Green Infrastructure. Since evidence shows that tourism development in the D-8 countries is still increasing carbon emissions, the D-8 governments should

implement policies that accelerate investment in environmentally friendly infrastructure at tourist destinations. This could include facilitating the use of renewable energy in hotels and tourist attractions, increasing the availability of electric transit vehicles for tourists, and constructing waste management facilities for recycling and wastewater treatment. These steps will serve the link between tourism growth and emissions while maximizing the long-term benefits of a cleaner environment for the tourism industry.

2. Emissions regulations and sustainability certification incentives. The D-8 should implement stricter environmental policies, such as carbon taxes or emission limits for tourist transportation modes (aircraft, cruise ships, and tourist buses), as well as mandatory energy efficiency standards for hotels and restaurants. Additionally, promoting sustainable tourism certification (e.g., Green Globe, EarthCheck) can accelerate the tourism industry's adaptation; investments that improve the EPI have been shown to drive tourism revenue growth. Certification programs will incentivize tourism businesses to conserve energy and water, while enhancing the appeal of D-8 destinations among environmentally conscious travelers.

3. Institutional strengthening and policy coordination. The results of the symmetric test indicate that long-term improvements in EPI scores have not significantly impacted tourism. This suggests that environmental efforts are often not supported by a robust policy framework. Therefore, D-8 countries must improve cross-sectoral governance by harmonizing regulations between agencies (e.g., tourism, environment, and transportation), eliminating bureaucracy and corruption, and providing fiscal incentives for green investment. One way to do so is by offering tax breaks or soft loans for environmentally friendly tourism projects. Improving the quality of regulations and incentives ensures that sustainability policies are implemented effectively and environmental improvements translate into added value for the tourism sector.

4. Balance Conservation with Capacity. Manage visitor numbers in fragile destinations to prevent over-tourism and environmental degradation. Adopt measures such as visitor caps in ecologically sensitive areas (e.g. national parks, coral reefs), timed entry permits, or off-season promotions. Invest in the conservation of natural and cultural sites to maintain their appeal. The D-8 strategy explicitly recommends striking a balance "between conservation and usage levels" and managing tourism "responsibly especially in fragile destinations". By controlling carrying capacity and involving local communities, countries can preserve attractions that drive tourism

revenues.

5. Leverage Regional Cooperation. Use the D-8 platform to share best practices in green tourism and to develop a common tourism brand emphasizing sustainability. Joint marketing of D-8 as a multi-destination route with high environmental standards could attract eco-conscious travelers. The member countries can also collaborate on transnational eco-tourism circuits (e.g. linking natural heritage sites across borders) and on mutual recognition of sustainability certifications. Such coordination reinforces the credibility of environmental commitments and helps D-8 nations compete for a growing global market of "sustainable tourists."

Each of these recommendations aims to decouple tourism development from environmental harm. For example, improved infrastructure and tougher regulations can break the historical link between tourism growth and higher emissions. By contrast, neglecting environmental issues risks long-term declines in tourism: as this study's findings and those of others show, tourists may eventually avoid heavily polluted destinations (mirroring the negative short-run impact seen in Pakistan). Therefore, D-8 policymakers should heed the evidence and advance measures from green investment to sustainable certification that allow the industry to flourish without undermining the natural resources on which it depends.

So that the panel analysis reveals that environmental quality has a significant asymmetric effect on D-8 tourism. Sound policy must address not only the economic drivers of tourism but also the environmental constraints. By implementing a suite of green measures including clean infrastructure, emission controls, and sustainability standards D-8 countries can foster tourism growth that is both economically and ecologically sustainable. As Acheampong (2018) emphasizes, accounting for nonlinearities is crucial: with the right policies, positive environmental shocks can be leveraged to boost tourism, while negative shocks can be minimized. This balanced approach will help ensure that the tourism industry contributes to long-term prosperity without compromising the environment.

5.3 Limitations of the Study and Future Research

Even though this study tells us a lot about what affects and impact of environmental performance on the tourism industry, it is essential to note that it has some limits. The panel data for D-8 countries (2008-2024) are limited by the availability and consistency of indicators. For example, the Environmental Performance Index (EPI) is updated infrequently and combines many measures, so annual or country-level values may require interpolation or proxies. Likewise, CO_2 emission data from different sources may have reporting lags or methodological differences. Such issues can introduce measurement error or noise into the analysis. The accuracy of the research may depend on the availability and quality of the data. Also, the study focused on specific input factors and did not look at other things that could affect tourism industry, like marketing, investment or other factors that may affect.

Future work should extend the analysis beyond the D 8 to assess whether the observed tourism environment relationships hold elsewhere. This could involve adding other regional blocs (e.g. G20, ASEAN, OIC countries) or conducting country-specific case studies with more disaggregated data. Another important direction is to include variables that mediate or moderate the tourism environment link. Potential candidates are energy consumption (total or per capita), renewable/clean energy share, green technology investment, and measures of institutional quality or environmental policy effectiveness and you can add dummy variable such as Covid-19.

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