ASSESSING SUSTAINABLE TRAVEL BEHAVIOR AND CARBON FOOTPRINT CLIMATE IMPACT: A STUDY OF TOURISTS' TRANSPORTATION CHOICES IN BUDAPEST HOSTELS

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1. INTRODUCTION AND OBJECTIVES

The global tourism industry significantly contributes to greenhouse gas (GHG) emission, accounting for roughly 8% of global carbon emission. Of this, the biggest percentage emanates from the transportation, it is therefore one of the fastest-growing environmental concerns arising from continued growth in aviation (Lenzen et al., 2018). Indeed, this sector has risen annually around 4% per year growth, which gradually increases sustainable tourism needs. Transportation emissions, particularly from air travel, are among the fastest-growing sources of carbon emissions globally (Lenzen et al., 2018).

The adverse impact of greenhouse gases (GHG) emissions caused by humans is drastically changing the social, political, and environmental scene. Many scientific investigations have also attributed these emissions to global warming and therefore play a central role in climate change. The term carbon footprint is one of the most significant terms for understand and measure impacts of human activities on the environment.

A carbon footprint measures the total greenhouse gas emissions produced directly or indirectly by an organization, service, event, or product. It is expressed in terms of CO_2 equivalents and is based on a life cycle assessment approach, which considers emissions generated from the beginning to the end of a process or activity. By calculating the carbon footprint, we can identify opportunities to reduce CO_2 emissions and highlight areas where emissions reductions or compensations are possible.

This methodology is essential in the context of sustainable travel, as different modes of transportation contribute differently to the carbon footprint. Understanding these differences allows for better decision-making regarding travel options and emphasizes the importance of promoting eco-friendly alternatives to mitigate climate change.

The purpose of this thesis is to explore the carbon footprint generated by different transportation choices made by tourists visiting Budapest and to assess the potential for reducing these emissions through more sustainable travel behavior.

In recent years, global CO_2 emissions from transportation have been rapidly increasing. In 2022, following the rebound in travel post-COVID-19, transport emissions went up by 3%, exceeding the reductions achieved during the pandemic (Transport - Energy System - IEA, n.d.). With air travel being one of the most carbon-intensive forms of transportation, it has become a significant contributor to climate change. Aviation not only emits large quantities of CO_2 but also releases nitrogen oxides and water vapor, which amplify the warming effect through a process known as radiative forcing (Zhang et al., 2009). In contrast, rail travel is recognized as a much more sustainable option due to its lower carbon footprint per passenger-

kilometer. This difference in carbon intensity between planes and trains highlights the importance of promoting more sustainable transportation choices among tourists.

Hungary, and Budapest in particular, serves as an ideal case study for examining these transportation choices. In 2021, Hungary received 7.93 million tourists, ranking 13th globally. Budapest's well-developed transportation infrastructure includes an extensive rail network that spans 7,687 kilometers, alongside other modes of travel such as buses and airplanes. Despite its relatively small size, Hungary ranks first in Eastern Europe in terms of tourist numbers relative to its population. Budapest's appeal as a tourist destination is evident in its economic impact, with the tourism sector contributing approximately $5.78 billion to the country's GDP in 2021 (Hungary: Country Data and Statistics, n.d.).

The main issue addressed in this thesis is the significant carbon footprint generated by tourist transportation choices, particularly the use of air travel. Despite growing awareness of the environmental impact of CO_2 emissions, many tourists prioritize convenience and cost over sustainability when selecting their mode of transport. This gap between awareness and action contributes to the growing carbon footprint of tourism. The research will focus on understanding the potential CO_2 savings that could be achieved if tourists opted for more sustainable modes of transportation, such as trains, over more carbon-intensive options like air travel.

The primary goal of this thesis is to assess how tourists' transportation choices impact their carbon footprint and to determine the potential for reducing emissions through more sustainable travel options. Specifically, the research will focus on the following objectives:

Measuring the Carbon Footprint: Quantify the carbon emissions generated by different modes of transportation used by tourists traveling to Budapest, using established carbon footprint calculators and formulas.

Comparing Transportation Modes: Analyze and compare the carbon intensity of air travel versus rail travel, assessing the potential CO_2 savings if more tourists opted for trains over planes for short to medium-distance travel.

Raising Awareness: Assess the level of awareness among tourists about the environmental impact of their travel choices and determine whether this awareness influences their decision-making process. The study will explore whether providing information about the carbon footprint could encourage more sustainable travel behavior.

Providing Recommendations: Offer practical recommendations for reducing the carbon footprint of tourism in Budapest, including policy suggestions for promoting sustainable transportation options like rail travel.

This research is crucial for advancing the understanding of how transportation choices in tourism contribute to climate change and what can be done to mitigate these impacts. By providing a detailed analysis of the carbon footprint associated with different travel modes, this thesis will contribute to the comprehensive conversation on sustainable tourism and environmental management. The findings could inform future tourism practices and transportation policies, both in Budapest and globally. Encouraging more sustainable travel behavior among tourists could lead to long-term reductions in CO_2 emissions, helping to align the tourism industry with global climate goals, such as the Net Zero Emissions target by 2050.

This study will focus on tourists staying in hostels in Budapest, with data collected through surveys that gather information on their transportation choices, awareness of environmental impacts, and willingness to change for more sustainable practices. The research will be limited to certain transportation modes, primarily focusing on air travel and rail travel, as these represent the most significant differences in carbon intensity. One limitation of the study may be the availability of accurate data on individual carbon footprints, as this can vary depending on several factors, such as distance traveled and specific transport routes.

2. LITERATURE REVIEW

According to the United Nations World Population Prospects 2024, there are approximately 8.2 billion people, and this number is expected to continue growing over the next few decades. Developing nations will see their populations increase, which will also drive the demand for natural resources (World Population Prospects 2024: Summary of Results - World, 2024).

The growing exponential representative curve of the world's human population has driven the increase in demand for natural resources, which can be due to human needs and the modern way of life largely focused on capitalism (Martins-Oliveira, 2022).

Population demands increase greenhouse gas emissions, which are directly related to climate change and the increase in Earth's temperature. This fact could compromise the lives of many organisms in less than a century (Martins-Oliveira, 2022).

According to Valls-Val & Bovea (2021), the term "carbon footprint" has become very popular but also complex to understand; however, it is defined by the IPCC Guidelines (2006) as "a representation of the effect on climate in terms of the total amount of greenhouse gases (GHG) that are produced, measured in units of CO2e as a result of the activities of an organization".

In 2006, the world transport sector emitted 6.5 Giga tons of carbon dioxide (CO_2), approximately 23% of CO_2 emissions. According to the Organization for Economic Cooperation and Development (2008), air transport could, based on a ''business as usual scenario," grow from 14.8% in 2010 to 23.0% of transportation CO_2 emissions in 2050. This is partially due to more readily available environmentally friendly energy in the future for ground-based transportation compared to air transport and the faster growth rate of air transport compared to other modes (Zhang et al., 2009).

Taking into account the complexity of the topic and the importance of understanding the different approaches to the impact of tourism on the environment, this literature review will be structured around three main aspects: the methodology for calculating the carbon footprint, the environmental impacts of the different modes of transport, and the strategies for mitigating tourism-related emissions. By exploring these three points deeply, it will be possible to have a better understanding of how they interconnect and influence sustainability in the tourism sector. This will allow us to identify the challenges and opportunities for adopting more sustainable travel practices.

1.1 MEANING AND BASIS OF CARBON FOOTPRINT

While many studies have focused on the emission of green gases and the carbon footprint connection, few have addressed the carbon footprint term. Although ecologist William Rees explain that the term "ecological footprint" was first use in 1992 and it was a multinational oil corporation that popularized the Carbon footprint term in the public mind. They reframed the ecological footprint as a person's carbon footprint with the aim of advertising in 2004. (Greenwood, 2022)

Carbon footprint is also related to ecological footprint; these are crucial terms when discussing sustainability analysis. Both are commonly referenced in manufacturing and production of commodities and goods in order to indicate the connection of these processes detrimental effects on gaseous emissions. The majority of people use the term "carbon footprint" on a daily basis, without accordance with the metrics or quantification methods, mentions (Elmogahzy, 2020). The basic standard for a carbon footprint is the representation of a specific volume of emissions of gases that are related to climate change and connected to activities of production or consumption (Elmogahzy, 2020).

Fortunately, carbon footprint guidelines, including the GHG Protocol, ISO/TS 14067, and PAS2050, as well as life-cycle carbon emissions assessments, are receiving more attention nowadays. However, the limits, scope, units of greenhouse gas emissions, and methods used for the carbon emission calculations frequently differ (Fenner et al., 2018).

Three methods can be used to measure the overall amount of carbon emissions: (1) focusing only on carbon dioxide; (2) incorporating the six gases CO_2, CH4, N2O, HFCs, PFCs, and SF6 identified by the Kyoto Protocol; or (3) incorporating a variety of greenhouse gas emissions as defined by the framework of the Intergovernmental Panel on Climate Change (IPCC). The most widely used approach is the IPCC framework, which was created to make it easier to report carbon emissions in accordance with the Kyoto Protocol. With this approach, greenhouse gas emissions are reported, taking into account the specific effects of each gas by utilizing the Global Warming Potentials (GWP) of the gases, which are stated in kilograms of carbon dioxide comparable (kg-CO_2eq) (Fenner et al., 2018).

The IPCC Guidelines (2006) describe a "carbon footprint" as "a representation of the effect on climate in terms of the total amount of greenhouse gases (GHG) that are produced as a result of an organization's activities, measured in units of CO2e." The following formula can be used to determine the greenhouse gas emissions from each source: ES = ADS × EFS.

Where the greenhouse gas (GHG) emissions from a specific source (ES) are derived from the product of the activity data from that source (ADS), which quantifies the source in

units (such as liters of petrol or kilowatt-hours of electricity), and its corresponding GHG emission factor (EFS), a coefficient that facilitates the conversion of activity data into GHG emissions, summarize (Valls-Val & Bovea, 2021).

2.1.1 Kyoto Protocol

The Kyoto Protocol, a milestone international agreement adopted in 1997 and enforced in 2005, is a crucial agreement under the United Nations Framework Convention on Climate Change (UNFCCC). This protocol places specific obligations on industrialized nations, demanding that they reduce or eliminate their greenhouse gas emissions in accordance with legally enforced goals. Furthermore, the protocol acknowledges these nations' historical role in contributing to global warming, thus calling for their commitment to address this responsibility (Kyoto Protocol to the United Nations Framework Convention on Climate Change, 2018).

The protocol introduced market-based mechanisms, such as carbon trading, which enable countries to meet their emissions reduction targets. These mechanisms include emissions trading, clean development projects, and joint implementation initiatives. Crucially, the protocol established a global framework for reducing greenhouse gas emissions, providing the foundation for standardized carbon footprint calculations across various sectors, including transportation, energy, and manufacturing (Kyoto Protocol to the United Nations Framework Convention on Climate Change, 2018).

The protocol parties gather annually during the Conference of the Parties (COP) to assess performance, get update on activities, and make new goals. Moreover, the Meeting of the Parties to the Kyoto Protocol (CMP) is held annually alongside the COP to address matters related to the protocol specifically. The first commitment period was 2008–2012; the second commitment period was agreed in the Doha Amendment but some countries including Canada, have withdrawn (Shishlov et al., 2016).

The Kyoto Protocol's goals were determined based on scientific evidence of climate change and the principle of "common but differentiated responsibilities," which recognizes that industrialized countries are historically more responsible for greenhouse gas emissions. These goals focus on reducing emissions of six greenhouse gases, primarily carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (Doan et al., 2024).

The reduction targets for each country were based on their emission levels relative to 1990, known as the base year. The countries committed to reducing their collective emissions by an average of 5.2% below 1990 levels between 2008 and 2012 (the first commitment period). These targets were determined by negotiations, considering each country’s economic capabilities and level of development. Since the convention is a multilateral agreement, no one

nation can run it alone. To track developments, compliance mechanisms were set up, requiring nations to publish their emissions through national inventories and meet legally mandated targets. Penalties for noncompliance include severe reductions in subsequent service periods (Shishlov et al., 2016).

According to the literature review, the carbon footprint concept is intimately related to the Kyoto Protocol and the subsequent efforts to address climate change. Setting emission limits straightened the way for modern carbon accounting methods that assess and mitigate environmental impacts, promoting sustainable development worldwide.

2.1.2 Paris Agreement

Adopted in 2015, the Paris Agreement, is consider as an important landmark framework for addressing the global climate action with ambitious goals to collectively prevent the global warming from rinsing more than 2ºC or even try to works towards 1.5 C above pre-industrial levels (UNFCCC, 2015).

Additionally, this commitment puts carbon footprint on top of the environmental agenda with clear consequences for its estimation and regulation across aspiring policies. The guidelines for CO_2 emissions laid down in the Paris Agreement are essential because they set targets and methods for calculating and monitoring emissions to encourage the use of transparent and standardized measurements compatible with available data (Rogelj et al., 2016).

Moreover, it emphasizes the relevance for ensuring high quality and availability of the carbon information that can help people and firms to make commitments that will support climate objectives. Linking tourist transportation emissions with the Agreement can enhance awareness of contribution to national emission targets and make the Agreement relevant for highly methodological but also practical analysis of sustainable tourism (Quéré et al., 2018).

2.1.3 The Intergovernmental Panel on Climate Change (IPCC) Guidelines

The most recent edition of the IPCC Guidelines is the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories published in 2006, which offer methods for calculating national inventories of greenhouse gas removals by sinks and anthropogenic emissions by sources. In order to provide a current and reliable scientific foundation for supporting the development and ongoing enhancement of national greenhouse gas inventories, the IPCC Methodology Report titled The 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2019 Refinement) was released in 2019 (Publications - IPCC-TFI, n.d.).

These guidelines serve as a standard framework that helps countries develop their own

national GHG inventories in a rigorous and comparable manner. The key details are that the 2006 IPCC Guidelines for National Greenhouse Gas Inventories are the foundational guidelines countries use to estimate their national GHG emissions, and the 2019 Refinement provides an updated and refined version of those guidelines without replacing them entirely. The 2019 Refinement details certain sectors, gases, and emissions factors.

The IPCC developed these guidelines to ensure accurate, transparent, and consistent reporting of GHG emissions across countries. This is critical for climate negotiations and monitoring progress toward global climate targets (Penman et al., 2000).

2.1.4 The Greenhouse gases (GHG)

To further emphasize comprehension of the concept of carbon footprint, it is essential to analyze greenhouse gases since they are directly related to climate change. The carbon footprint was created to monitor not only carbon dioxide (CO_2) but also other greenhouse gases that contribute significantly to global warming. The recent increase in CO_2 concentration in the atmosphere is mainly attributed to human activities, such as burning fossil fuels, including coal, oil and natural gas. This increase in CO_2 emissions intensifies the "greenhouse effect," resulting in global warming and climate change that can have dangerous consequences for the planet. The greenhouse effect is caused by various greenhouse gases, with carbon dioxide being the primary contributor (Shaikh et al., 2018).

According The National Geographic article, The Greenhouse Effect and Our Planet offers a more concise explanation of the greenhouse effect. The greenhouse effect is a natural process that is essential for life on Earth but is intensified by human action. It occurs when certain gases in the atmosphere, such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), allow sunlight to enter but retain some of the heat radiated by the Earth's surface. This process keeps the planet's temperature at habitable levels.

However, since the Industrial Revolution, human activities such as burning fossil fuels, deforestation, and intensive agriculture have increased the concentration of these gases in the atmosphere, intensifying the greenhouse effect and leading to global warming. The consequences of global warming include melting glaciers, rising sea levels, changes in precipitation patterns, and changes in the habitats of several species (The Greenhouse Effect and Our Planet, n.d.).

Greenhouse gases (GHG) refer to a class of atmospheric gases that can absorb and, subsequently, release thermal infrared radiation. The existence of greenhouse gases (GHGs) is what causes the greenhouse effect. The Earth's surface temperature would drop by about 19 degrees Celsius relative to its current level if greenhouse gas emissions were reduced (Islam et

al., 2022).

Greenhouse gases, or GHGs, are present in the atmosphere in measurable quantities due to natural processes and human activity. The five most common greenhouse gases are water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxides (N_2O), and ozone (O_3) (Ripple et al., 2022).

Human activities, particularly transportation, significantly contribute to the increase in global greenhouse gases like CO_2 emission across many different sectors (Yin et al., 2023b). Transport car vehicles produce around 33% of these emissions, while power plants are responsible for about 40%. Buildings account for 12% of carbon emissions; deforestation accounts for 20% to 25%. Finally, airplanes account for about 3.5% of the world's carbon emissions (Osman et al., 2023).

The rise in the concentration of carbon dioxide (CO_2) levels, expressed in parts per million (ppm), is caused by various human activities, adding to pressure on the planet's land resources. Carbon dioxide (CO_2) concentration in the atmosphere has continuously increased from 2011 to 2023. Table 1 highlights the fixed rise in CO_2 levels from 389.8 ppm in 2010 to 417.06 ppm in 2022. This rise serves as the main factor that is accountable for the occurrence of global warming and the negative effects it has on the planet (Shah et al., 2024b).

Table 1 - Level of Greenhouse gases from 2010

Year	**CO_2 (ppm)**	**CH_4 (ppb)**	**N_2O (ppb)**	**SO_2 (ppt)**
2010	389.8	5.2	1.08	0.27
2011	391.6	4.92	0.9	0.28
2012	393.8	4.97	0.81	0.31
2013	396.4	5.64	1.01	0.32
2014	398.5	12.78	1.24	0.34
2015	399.4	10	0.9	0.32
2016	403.3	7.03	0.66	0.34
2017	405	6.88	1.02	0.35
2018	407.9	8.76	1.16	0.35
2019	410.5	9.67	0.91	0.33
2020	412.5	15.21	1.34	0.34
2021	416	17.6	1.29	0.39
2022	417.06	14.77	1.26	0.37

Note. Research Collection from Global monitoring laboratory.
Source: Shah et al. (2024b)

2.1.4.1 Understanding CO_2e as a Standard for Emissions Reporting

As matter of fact Carbon dioxide equivalent (CO_2e) is an internationally accepted measure that combines the climatic effect of all six-greenhouse gases, it is used to express their impact in terms of carbon dioxide, to make emissions reporting easier. Carbon dioxide equivalent (CO_2e) helps further compare emissions since greenhouse gases influence global warming in dissimilar ways. This is especially useful in transport emissions factors where one or a number of greenhouse gases such as methane (CH_4) or nitrous oxide (N_2O) may be emitted based on fuel type or transport method. For sustainability studies like the one in tourism CO_2e works as a summarizing parameter that shows total emissions in their equivalent CO_2 thus keeping reporting simple and comparable across the studies or regions (Melián-Navarro and Ruiz-Canales, 2020).

2.1.4.2 The Scientific Background of Global Warming Potential (GWP)

Global Warming Potential (GWP) is the scientific foundation used to make comparisons between emissions of different greenhouse gases (GHGs) by converting them into a unified measure referred to as Carbon dioxide equivalent emission (CO_2e). With its infancy in the IPCC's First Assessment Report, GWP is computed on defined periods including 20 year, 100 year, or 500 year timespans. The United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol used the 100-year GWP as the baseline that made emissions comparable across the sectors, and can facilitate climate measures with multiple components (IPCC, 2014). For instance, while CO_2 received a 100-year GWP score of 1 ton, other gases such as methane had a much higher score of 28-36, making clear why GWP is necessary for the elaboration of harmonized metrics of emissions and rational climate policies (Core Writing Team et al., 2014).

2.1.5 Carbon Footprint Scope and Emission Scopes

The concept of scopes has been developed to help differentiate the direct and indirect emission sources with the goal of evaluating and quantifying green gas (GHG) emissions effectively. Each of these three categories stated as Scope 1, Scope 2 and Scope 3 are fundamental to improving clarity and transparency across organizational types and various sectors. By determining the emission sources based on these scopes, we can guarantee a more accurate and consistent method of measuring greenhouse gases in special when multiple organizations engage and operate using the same system (Ranganathan et al., n.d.).

The comprehension of emissions scopes will serve as a basis for assessing the carbon footprint of tourist's transportation choices for our case study in Budapest hostels. This approach is essential considering that prevents counting emissions twice but also enables us to

understand the levels of direct and indirect impact that carbon footprint calculations can have in the environment. Although scope 3 is the most essential for my analysis since it covers transportation emissions also the environmental impact of tourism activities, knowing the scopes will improve the study framework and provide better comprehensive results.

According to the Greenhouse Gas Protocol, developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), standard scopes 1 and 2 are outlined to reduce and prevent multiple organizations from reporting the same emissions under the same scope. This minimizes the possibility of double counting (Ranganathan et al., n.d.).

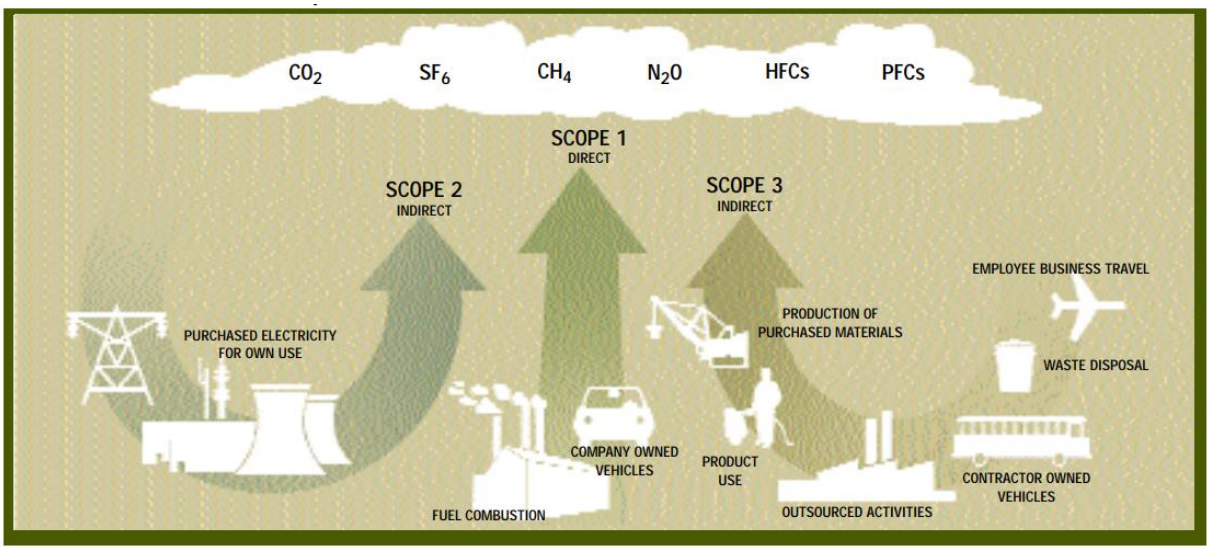
Scope 1 include direct greenhouse gas (GHG) emission by sources which a company directly controls or owns, for example, emission from fuel combustions, boilers equipment and furnaces owned by the corporation. However, like with other GHGs not included by the Kyoto Protocol, such CFCs and NOx, emissions from burning biomass are not included in Scope 1 and are reported separately (Ranganathan et al., n.d.).

Scope 2 include indirect emissions related with the generate power and purchased electricity consumed by the company. Since the emissions occur at the place when electricity is produced the company that uses the electricity reports these emissions, as it reaches the operational boundaries of the organization (Ranganathan et al., n.d.).

Finally, Scope 3, includes covers all further indirect emissions from the company's operations that come from sources that are not directly owned or controlled. This covers emissions from the consumption of sold goods and services as well as those produced during the manufacturing and delivery of purchased goods and fuels. Scope 3 allows for a more comprehensive view of the company’s overall environmental impact (Ranganathan et al., n.d.).

This comprehensive framework across the three scopes is essential for controlling and lowering emissions, both direct and indirect, throughout a company’s value chain. The picture offers a visual illustration of how businesses account for greenhouse gas (GHG) emissions in three different scopes: Scope 1 (direct emissions), Scope 2 (indirect emissions from purchased electricity), and Scope 3 (other indirect emissions).The framework shown ensures that companies account for report their emissions from the Scope 1 and Scope 2 separately, enhancing transparency. To improve clarity, companies may subdivide data by breaking it down by country, facility, or activity type. Additionally, while the focus is on the six gases covered by the Kyoto Protocol (CO_2, SF6, CH4, N2O, HFCs, and PFCs), companies can provide data for other GHGs to offer a more complete picture (Ranganathan et al., n.d.).

Figure 1 - Overview of Scopes and Emissions across a Value Chain



Source: World Resources Institute & World Business Council for Sustainable Development. (n.d.). The Greenhouse Gas Protocol: A corporate accounting and reporting standard (Revised ed.).

Additionally, the context of my study, the focus on individual carbon footprint calculations for transportation is directly related with Scope 3 emissions. All indirect emissions, including those produced by tourists' modes of transportation, are included in scope 3. For hospitality companies, the emission from travel by plane, train, bus or car are categorized in the scope 3 given that these emissions are outside their direct operational control but are a direct consequence of the services they provide. We can better comprehend the way indirect emissions contribute to the overall environmental impact of tourism by calculating those emission related to transportation (Gößling, 2013). This emphasizes the significance of promoting sustainable travel practices to reducing the scope 3 emissions; furthermore provide useful knowledge about the part indirect emissions play in the tourism industry.

1.2 TRANSPORTATION EMISSIONS

Considering my studying on transport choices made by tourists in Budapest, it is important to take in to account that the city is located in Eastern Europe and is part of the European Union. With a population of around 747 million inhabitants, Europe is formed by 50 countries in a territory extending over 10,530,751 km². Budapest's geographical position favors access to different means of transport, facilitating travel by train and plane (Juhász et al., 2014). The well-developed rail infrastructure, connecting the city to several other European capitals, resulting in more sustainable options for travel compared to air transport (Gaal et al., 2015). However, tourists' choice of transport mode is influenced by factors such as cost, travel time, essentials, and convenience, which makes it necessary to analyze these preferences in the context of the carbon footprint and the options available (Dolničar et al., 2009).

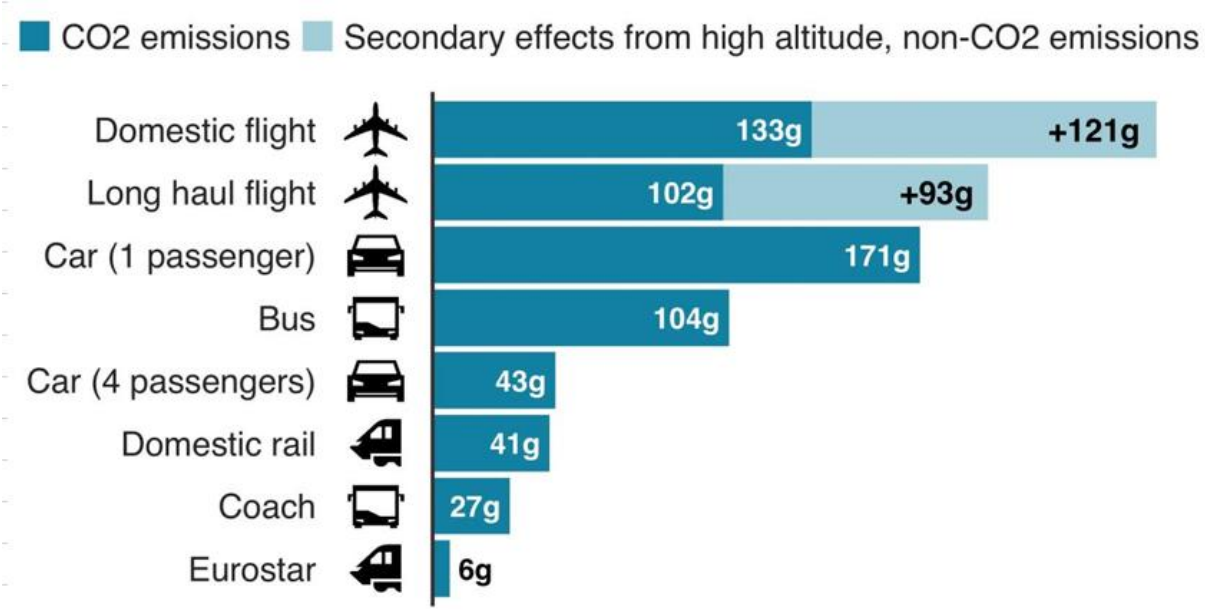
Quality and price are currently the most significant variables for passengers (Tica et al., 2011), however technology and performance are also significant elements (Dell'Olio et al., 2012). A comprehensive study on the environmental impacts of European tourism transport reveals that air travel and intercontinental tourism have the most significant negative effects (Peeters et al., 2007). This is because air transport generates a high level of greenhouse gas emissions that contribute to climate change. Similarly, research on the carbon impact of short-haul tourism in the UK found that transportation, particularly air and car-based travel, generate the largest carbon footprint, suggesting that switching to train and coach travel can lead to significant carbon savings (Peeters et al., 2007) (Filimonau et al., 2013).

In Europe, the main sources of transport emissions are road vehicles such as cars and trucks used for both personal and cargo transport. Another important factor is air travel, especially since short flights across the continent are common and produce many emissions per passenger mile. Particularly in port locations, ships and ferries utilized for both transportation and tourism also increase the environmental impact. Even though rail transit is more beneficial to the environment, it still has an impact because trains use non-renewable energy sources. Europe has a better rail network and more robust public transit systems than other regions of the world, such as North America, where people rely more on cars, or Asia, where emissions from cars and airplanes are rising quickly. However, Europe still faces difficulties controlling maritime and aviation transportation emissions (Gruetzmacher et al., 2020).

According to a BBC report, aviation emissions are a major contributor to global warming, with long journeys producing around 0.67 tonnes of CO_2 per passenger. Climate activist Greta Thunberg highlighted this issue by choosing to sail to a UN climate summit in New York on a zero-emissions boat instead of flying. The report compares the environmental impact of different transport modes, showing that rail travel is far more sustainable. For instance, a train journey from London to Madrid emits just 43kg of CO_2 per passenger, while the same trip by plane emits 118kg, or up to 265kg when including non-CO2 emissions. Factors like train type, electricity source, and journey length also play a role, making trains a greener alternative for reducing the carbon footprint in European cities (BBC News, 2019).

As the BBC illustrates, long journeys and domestic flights release the largest CO_2 emissions, with domestic flights releasing 133g. Cars and buses make considerable contributions, with respective contributions of 171g and 104g. Greener transport is crucial, as seen by the lower emissions produced by sustainable solutions, including domestic rail, coaches, and the Eurostar (BBC News, 2019).

Figure 2 - Emissions from Different Modes of Transport



Note: Car refers to average diesel cars.

Source: BEIS/Defra Greenhouse Gas Conversion Factors 2019 (BBC)

The European Union has also set strict CO_2 emission standards for new vehicles, pushing Automotive companies to produce more fuel-efficient cars and invest in electric vehicles (EVs). Europe has implemented various policies and measures to reduce transportation emissions, with different levels of success. Several cities, such as London, Paris, and Berlin, have established low-emission zones (LEZs) to restrict access to high-polluting vehicles (Longo et al., 2019).

These zones have effectively reduced air pollution and traffic-related emissions. Incentives for the adoption of electric vehicle (EV) vehicles, such as subsidies and tax breaks, have also been rolled out in many countries, resulting in increased sales of electric and hybrid vehicles (Zhang et al., 2014). Public transportation systems have been upgraded in cities like Budapest, where electric trams and buses are becoming more common (Ajanović et al., 2021). Investments in rail infrastructure, particularly high-speed trains, offer an alternative to long-flight journeys, reducing aviation emissions. While these efforts have shown progress, challenges remain, especially in aviation and road cargo, where emissions continue to rise. Overall, the policies are positively influencing, but further actions are needed to meet long-term climate goals.

2.2.1 CO_2 Emissions by Transport Sector

Transport accounts for more than a third of CO_2 emissions from end-use sectors. Partly because of continuing dependence on internal combustion engines driven by fossil fuels,

motorized transportation across land, sea, and air generate a significant contribution to global CO_2 emission. According to the International Energy Agency (IEA) in the recent years, the transportation sector has faced some changes and significant challenges following the rebound in activity after the Covid-19 pandemic. Transport CO_2 emission increased 3% over the previous year reflecting a rebound in passenger and cargo transport (Transport - Energy System - IEA, n.d.).

The alarming pattern noticing in the transport emission with an annual average growth rate of 1.7 % between 1990 and 2022, been faster than any other end-use sector except for industry. To be able to achieve the targets set in the Net Zero Emissions (NZE) by 2050 Scenario, the industry needs to reduce emission more than 3% annually until 2030. Accomplishing this goal will demand fiscal incentives, strong regulations, and large infrastructure investments to support low and zero emission vehicles (Transport - Energy System - IEA, n.d.).

Multiple countries with significant economies are implementing polices to speed the adoption of electric vehicles (EVs) to encourage the decarbonization of transport among all modes. Significant policy advancements were accomplished in the US in 2022, such as the Inflation Reduction Act, which intends to increase the use of EVs and the generation of hydrogen, synthetic fuels, and biofuels. In order to meet the country's net-zero goals by 2050, the U.S. Environmental Protection Agency (EPA) has suggested multi-pollutant emissions guidelines for vehicles. On the other continent, we have China that continues to dominate the global EV market, accounting for nearly 60% of car sales and leading in light commercial vehicles, two-wheelers, buses, and trucks (Transport - Energy System - IEA, n.d.).

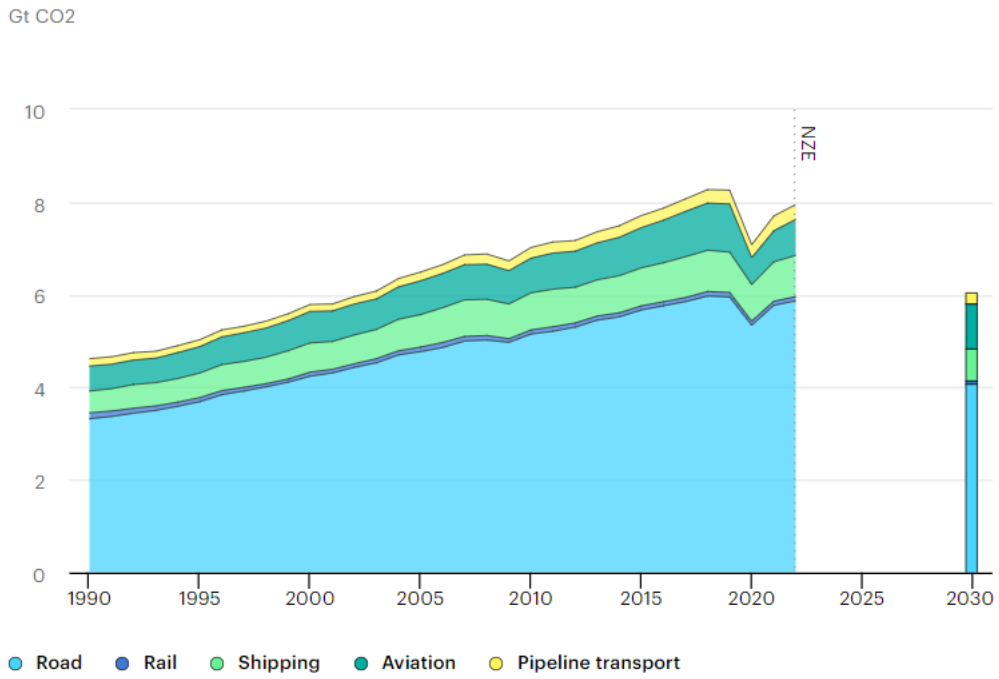
The European Union is advancing the transition to EVs through the Green Deal Industrial Plan and the Alternative Fuels Infrastructure Regulation, which requires public charging infrastructure. Additionally, the EU is working on legislation to encourage the use of low-emission alternatives to aviation fuel sourced from fossil fuels and develop a new emissions trading system that accounts both maritime and road transport emissions. Certain nations are making significant progress in reducing transport-related emissions like Norway been the leader in eletric vehicle adoption, with around 90% of new sales in 2022 being electric vehicles (Transport - Energy System - IEA, n.d.).

Further more, to encourage EV adoption, the Australian government has created a National Electric Vehicle Strategy and pledged to set a fuel efficiency requirement for light-duty vehicles. Consequently, in order to promote domestic battery manufacture and offer incentives for sophisticated automotive components, such as battery electric and hydrogen fuel

cell vehicles, India has implemented the Production Linked Incentives (PLI) system(Transport - Energy System - IEA, n.d.).

Despite ongoing efforts to reduce emissions, the current increase in CO_2 emissions emphasizes the critical need for continual attempts to reduce emissions in the transportation sector, even though there have been significant advancements in regulations and activities in this area. A sustainable and decarbonized future in accordance with international climate targets will depend on the success of these initiatives in guiding the transportation industry towards achieving substantial emissions reductions (Transport - Energy System - IEA, n.d.).

Figure 3 - Global CO_2 emissions from transport by sub-sector in the Net Zero Scenario, 2000-2030



Source: IEA. Licence: CC BY 4.0

Meanwhile, evaluating transportation emissions into the travel context is significant for many different reasons. Analyzing CO_2 emissions from different transportation options enables the identification of sustainable alternatives as one example promoting cycling or public transport, will result in instant an decreasing on the emissions (Transport - Energy System - IEA, n.d.).

From my studying some insights on travel behaviors can aid policymakers in creating regulations and incentives aimed at decreasing emissions related to transportation. This can foster eco-friendly tourism strategies that balance economic interests with environmental responsibility. By shedding light on the carbon footprint linked to various transportation methods, travelers can make better-informed decisions, encouraging a shift toward more

sustainable travel practices. Greater awareness can increase demand for greener options, stimulating changes within the tourism industry (Transport - Energy System - IEA, n.d.).

With the anticipated growth of the tourism sector, it is important to understand and address transportation emissions to meet global climate objectives. The environmental and economic pressures facing the sector amplify this urgency. In conclusion, assessing the role of transportation in CO_2 emissions within the tourism industry is critical for promoting sustainable travel behaviors, shaping effective policies, enhancing consumer awareness, and ultimately addressing climate change.

2.2.1.1 Road Transport: Passenger transport activity

Road transport has been essential in shaping modern travel, providing unparalleled flexibility and convenience for passengers. From the widespread adoption of cars in the early 20th century to the development of public transport systems like buses and trains, road transport revolutionized the way people move within and between cities. The ability to travel efficiently by road opened new avenues for commerce, tourism, and daily commutes, connecting rural and urban areas alike (Nakamura et al., 2004).

However, the environmental cost of this convenience is becoming increasingly clear. Passenger vehicles, including cars and buses, contribute significantly to global carbon emissions. In Europe, road transport remains the largest source of transportation-related greenhouse gas emissions, with cars accounting for the majority, but buses also playing a substantial role. These emissions not only affect climate change but also contribute to air pollution, especially in densely populated areas (Fuglestvedt et al., 2008).

While trains offer a lower-carbon alternative, the overall reliance on road transport has created pressing sustainability challenges. As demand for travel increases, addressing the emissions from passenger activity on roads is critical in meeting climate goals. Sustainable solutions, such as the shift to electric vehicles and improved public transport infrastructure, are vital in reducing the carbon footprint of road-based passenger activity (Brand et al., 2021).

Passenger transport activity in the EU-27 has seen remarkable growth over the past 27 years, peaking at 6 trillion passenger-kilometers in 2019, prior to the COVID-19 pandemic. This growth, driven primarily by road transport, reflects the increasing reliance on motorized vehicles, such as cars and buses, to meet daily mobility needs. By 2022, transport activity had already returned to near pre-pandemic levels, with around 5.6 trillion passenger-kilometers traveled. The rise in passenger activity, even after the pandemic, reveals the long-term trend of increasing demand for road-based travel in Europe (Passenger Transport Activity, 2024).

Despite this rise in overall activity, the modal share of passenger cars has remained

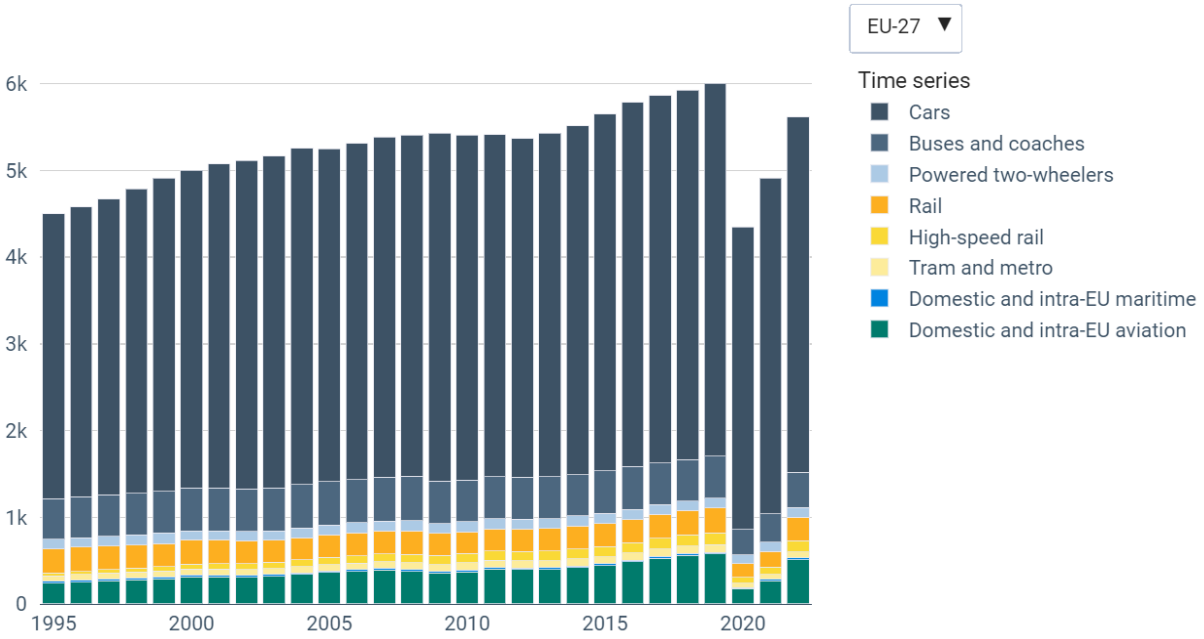
relatively stable, experiencing only a slight decrease of 1.4 percentage points between 1995 and 2019. This minor shift highlights the challenge of reducing the environmental impact of road transport, as cars continue to dominate passenger mobility in Europe. With road transport contributing significantly to greenhouse gas emissions, the increasing demand for travel complicates efforts to achieve climate goals and reduce the carbon footprint of the transport sector (Passenger Transport Activity, 2024).

Addressing the environmental challenges posed by this high level of road transport activity requires a multifaceted approach. While technological advancements, such as electric vehicles, offer potential solutions, managing demand is equally crucial. Strategies such as promoting a shift to active or collective transport modes, like cycling, walking, or public transport, can complement technological efforts. Additionally, improving accessibility to essential local services such as hospitals, schools, and grocery stores can reduce the need for long-distance travel, further mitigating the environmental impacts of road-based passenger transport (Passenger Transport Activity, 2024).

According to the European Environmental Agency (EEA) 4,100 billion passenger kilometers were driven in 2022. This mode was one of the primary forces behind the previously noted increase in transportation activity, along with aircraft. In the EU-27, the number of passenger kilometers driven by passenger cars rose by 24.8% between 1995 and 2022. Perhaps it is important to remember that these numbers represent how COVID-19 has affected passenger travel. In 2019, two years before to COVID-19, the amount of passenger kilometers driven by passenger cars had risen by 30.9% (4,299 billion passenger kilometers) compared to 1995. Notably, as Figure 4 illustrates, passenger automobiles made up the biggest percentage of all modes of transportation in the EU-27 in 2022, accounting for 73.0% of passenger kilometers travelled (Passenger Transport Activity, 2024).

The current level of passenger transport activity, the historical trend, and the anticipated rise make it very difficult to reduce the environmental impacts of passenger transport, including decarbonizing it. One potentially useful tactic for reducing the effects of mobility is to manage demand whenever feasible, for instance, by encouraging a move towards active or group modes of transportation or by making local services (like, for instance, schools, hospitals, pharmacies, and grocery stores) more accessible. This tactic ought to be employed in conjunction with policies that are more technologically orientated (OECD, 2021).

Figure 4 - EU-27 Passenger Transport Activity for Different Transport Modes



Source: EC, 2024d, EU transport in figures: Statistical pocketbook 2024, Publications Office of the European Union, LU

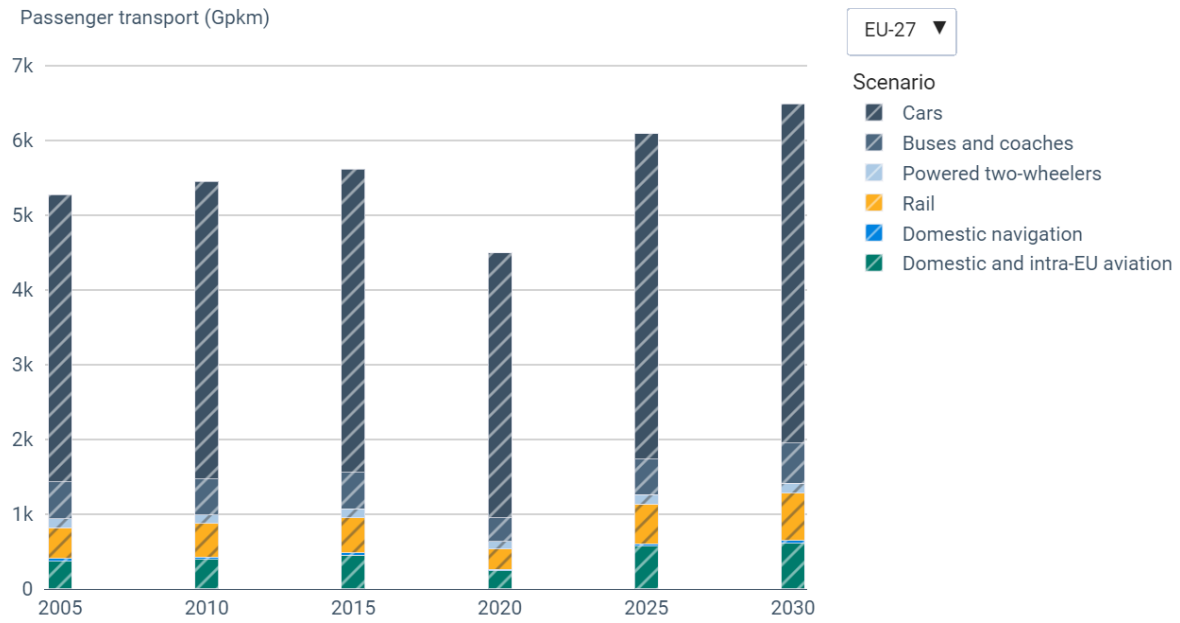
The European Commission's Sustainable and Smart Mobility Strategy aims to transition towards sustainable transport modes by 2030, including carbon neutral travel, doubling high-speed rail activity, and establishing 100 climate-neutral European cities. However, these measures assume increased activity without considering the transport mix. The MIX-FF55 scenario predicts passenger automobiles will remain the most common form of transportation in the EU-27, accounting for 69.9% of all passenger kilometers in 2030. Austria addresses this issue in its mobility plans until 2030 (Passenger Transport Activity, 2024).

Additionally, as Figure 5 illustrates, the European Commission's (EC) most recent MIX-FF55 scenario predicting that transport activity would continue to increase (EC, 2021d). According to this scenario, the number of passenger kilometers will rise from 5,618 billion in 2015 to 6,088 billion in 2025 and 6,487 billion in 2030 (Passenger Transport Activity, 2024).

Public transport, including buses, trains, trams, and metros, is a sustainable mode of transport due to lower emissions and energy consumption per passenger-km traveled. In the EU-27, public transport activity reached around 995 billion passenger-km in 2019, a 2.2 percentage point reduction from 1995. However, COVID-19 travel restrictions, perceived health risks, and changes in mobility habits severely affected these modes. Bus travel declined by 13.2%, train travel by 28.7%, and tram and metro travel by 8.4% in 2022 (Passenger Transport Activity, 2024).

Figure 5 - EU-27 passenger transport activity for different transport modes according to the

FF55-MIX scenario



Source: EC, 2021d, 'Excel files for MIX scenario - FF55 MIX energy-transport-ghg'

High-speed rail passenger transport increased from 32.5 billion passenger-km in 1995 to 134.0 billion passenger-km in 2019, with France, Germany, Spain, and Italy being largely responsible for this increase. During the pandemic, high-speed rail passenger transport decreased drastically, but a renewed interest in passenger sleeper trains has emerged. The European Railway Agency supports the development of additional night train connections and other long-distance cross-border services (Passenger Transport Activity, 2024).

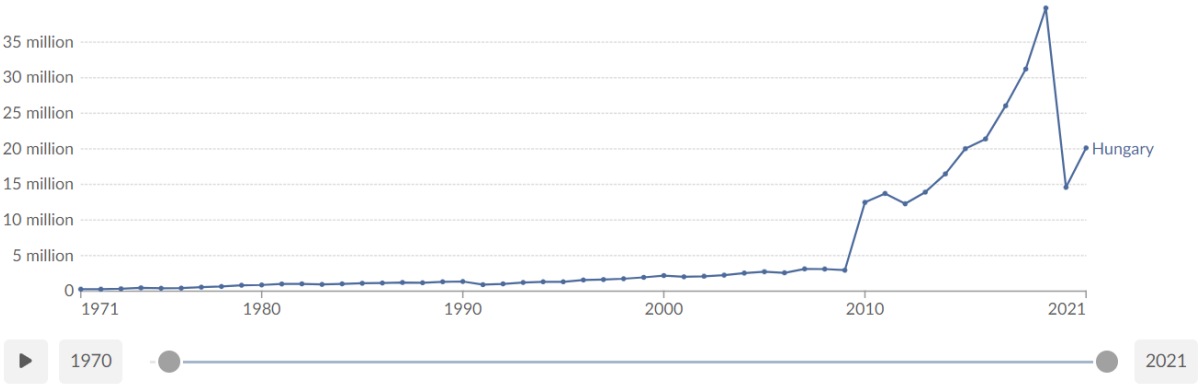
Public transport is expected to expand in the EU-27 to 1,174 billion passenger-km by 2030, with rail passenger transport accounting for 9.8% of all forecast transport activity. Bus and coach activity is expected to increase to 542 billion passenger-km by 2030, with a share of 8.4% (Passenger Transport Activity, 2024).

2.2.1.2 Aviation: A Growing Concern

While road transport remains the dominant contributor to emissions, aviation's environmental impact is rising rapidly. In Hungary, this is evident through the steady increase in air passengers from 1970 to 2021, with both domestic and international travel contributing to this growth (Hortay & Pálvölgyi, 2021). A visible drop in passenger numbers is noticeable in 2019-2020, corresponding to the global COVID-19 pandemic, but as the data shows, aviation has continued its upward trajectory since then. This surge raises concerns about aviation's contribution to CO_2 emissions, which, on a global scale, account for around 2.5% of total CO_2 emissions but are increasing faster than many other sectors (Gößling & Humpe, 2020). Addressing this issue will require solutions such as sustainable aviation fuels, advancements in

technology, and reconsideration of current travel patterns (Grewe et al., 2021).

Figure 6 - Hungary Air passengers from 1971 to 2021



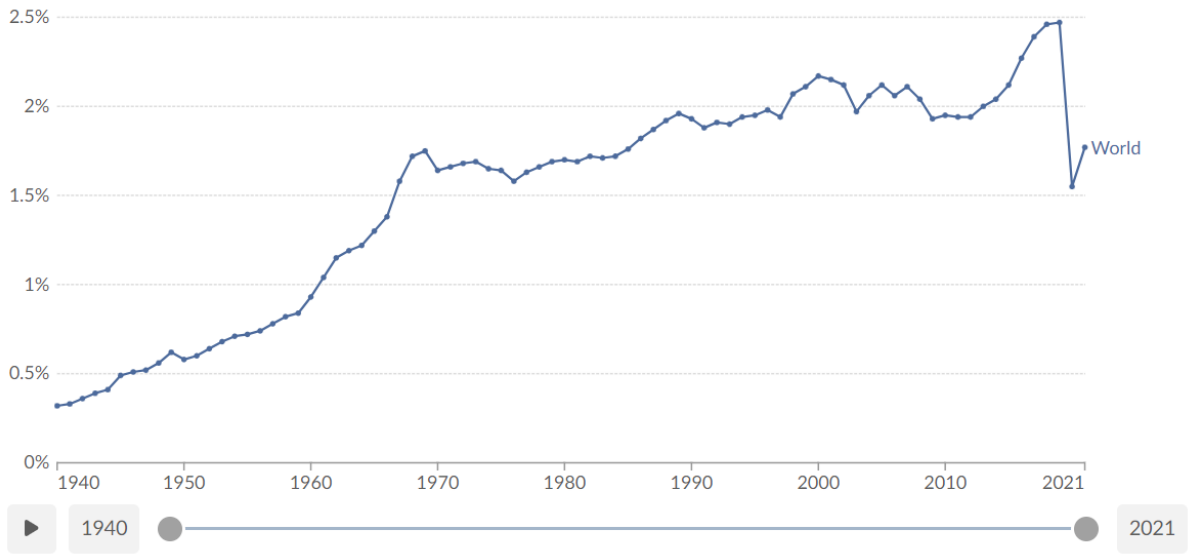
Note: Domestic and international passengers of airlines registered in the country. Passengers counted each time they travel.

Source: OurWorldinData and Multiple sources compiled by World Bank (2024)

Taking in consideration the aviation's Impact on Global Warming, While aviation accounts for around 2.5% of global CO_2 emissions, its overall contribution to climate change is higher, estimated at approximately 4% of global warming since pre-industrial times. This discrepancy is due to non-CO_2 climate impacts such as emissions of water vapor, soot, and sulfur aerosols, as well as contrails, which have a stronger warming effect. Hannah Ritchie (2024) reports that quantified aviation's total climate impact by calculating "radiative forcing", which measures how much energy the atmosphere retains compared to how much it radiates back into space. While CO_2 contributes to less than half of aviation's warming effect, non-CO_2 factors like contrails make up two-thirds of the sector's impact (Ritchie, 2024).

Moving forward, aviation is expected to become a larger share of global emissions because it's one of the hardest sectors to decarbonize. Other sectors, like road transport and electricity, are transitioning faster through renewable energy and electrification, whereas aviation lags behind due to the current lack of viable low-carbon alternatives. Progress in improving aircraft energy efficiency helps to slow emission growth, but significant reductions will require a shift to sustainable aviation fuels, electrification, hydrogen, or biofuels, which the sector has made limited progress on so far (Ritchie, 2024).

Figure 7 - Aviation's share of global CO_2 emissions from 1940 to 2021



Source: OurWorldinData and Multiple sources compiled by World Bank (2024)

The graph shows aviation's contribution to global CO_2 emissions from fossil fuels and land-use change from 1940 to 2021. It shows early growth, post-war boom, late 20th-century growth, and continued rise into the 21st century. Although aviation represents a small fraction of global emissions, its contribution has grown steadily over time. The graph suggests that aviation's share of emissions will likely increase in the future unless sustainable aviation technology breakthroughs are made (Ritchie, 2024).

1.3 SUSTAINABLE TRAVEL BEHAVIOR

Tourism is said to be one of the main drivers of job creation, income generation, and the promotion of culture and entertainment. By connecting with other industries, travel and tourism play a crucial role in increasing foreign investment, trade opportunities, and investments in public, private, and municipal infrastructure (Russo & Borg, 2002). However, the growth of tourism has also brought significant environmental and social challenges that need to be addressed (Bricker & Schultz, 2011).

Studying sustainable travel practices becomes increasingly important as the globe struggles with these challenges. To ensure the long-term sustainability of the tourist sector and its related advantages, a comprehensive examination of how people could change their travel behaviors and make better choices that drastically reduce their environmental impact is called for. Tourist activities, particularly transportation, contribute to the rising carbon footprint globally. As a result, governments and destination managers have been exploring strategies to encourage tourists to make more environmentally friendly transportation choices (Bi & Romão, 2021) (Bricker & Schultz, 2011). By promoting a better awareness of sustainable travel habits,

we may continue to benefit economically and culturally from international tourism while reducing the negative environmental effects noted by researchers like Churchill et al. (2022) and Kavta and Goswami (2022).

This literature review aims to investigate the factors that influence sustainable travel behavior and the strategies that destinations can employ to encourage more environmentally responsible tourism practices.

Among the need for more sustainable behavior, some of the factors that most influence tourists' transportation choices are related to cost and affordability. Price is a primary factor, especially if options like trains or buses offer a competitive price compared to air travel or private cars. Convenience and accessibility. Tourists usually prefer convenient and easily accessible modes of transportation. If public transportation, bike sharing, or pedestrian-friendly infrastructure are easily accessible and well-integrated, they are more likely to be selected. Poor connectivity, difficult scheduling, or lengthy wait times could discourage people from using more environmentally friendly solutions (Rarasati & Octoria, 2018).

Another crucial point for tourists' decisions is that they are making based on the information that they have about the destination. Increasing environmental awareness may lead them to make better decisions, like using trains or buses instead of high-emission vehicles like airplanes.(The title of the work is: **Ecological Footprint of Tourism**., 2023) Beyond that, the perceived enjoyment and engagement with the travel experience can also factor into tourists' transportation choices (Bi & Romão, 2021).

Comfort and safety are determinant factors in tourists' transportation choices, with many avoiding public transport if it is perceived as uncomfortable or unsafe. Sustainable options, like high-speed trains, which offer both comfort and safety, are more likely to appeal to eco-conscious travelers (Peeters et al., 2018).Time constraints also play a role, as tourists with limited vacation time may prioritize faster options, like flights, even if they are less sustainable. The availability of information about green transport options through hostels or campaigns can encourage eco-friendly decisions. Additionally, cultural norms, peer influence, and policies, such as discounts or city tolls, further guide tourists toward sustainable choices (Cheng et al., 2018).

According to Booking.com study emphasizes the difficult choices tourists must make between affordability and sustainability, especially in light of the climate issue and growing living expenses. Nearly half (49%) of travelers believe sustainable travel options are too costly, despite 76% saying they would like to travel more responsibly in the upcoming year. This highlights a conflict where tourists are caught between their need to protect the environment

and their financial limitations. Nonetheless, 43% of respondents said they are willing to pay extra for certified sustainable travel options, suggesting that some tourists value making eco-friendly decisions even if they are more expensive (Booking.com, n.d.).

Over half of travelers (51%) believe there are not enough sustainable choices, and 40% struggle to find ways to book eco-friendly experiences, even though 75% seek out local and authentic cultural activities that benefit the communities they visit. The research also reveals that lack of sustainable travel options and accessibility to information are significant barriers (Booking.com, n.d.).

Despite these challenges, 80% of travelers say that sustainable travel is important to them, and many are taking steps to reduce their environmental impact. For example, travelers are making sustainable choices such as using reusable shopping bags, turning off lights, and recycling, both at home and while traveling. Additionally, 43% plan their sightseeing to use sustainable transport options like walking, cycling, or public transportation (Booking.com, n.d.).

To advance sustainable travel, the sector needs to increase transparency and offer more certified, transparent solutions. 39% of travelers doubt whether options with a sustainable label are truly sustainable, despite the fact that 65% of travelers would prefer to stay in establishments with such a designation. This highlights the need for increased openness and actions to satisfy environmentally sensitive customers (Booking.com, n.d.).

When comparing sustainable travel behaviors across different countries, notable differences emerge. Mexican tourists stand out for their strong commitment to sustainability, with 91% saying it is important to them, well above the global average. Additionally, 90% are keen to travel more sustainably over the next year, and 73% feel reassured by properties with sustainable certifications. Mexican travelers are also more likely to demand sustainable travel options from companies and seek clarity on why certain options are labeled sustainable (Booking.com, n.d.).

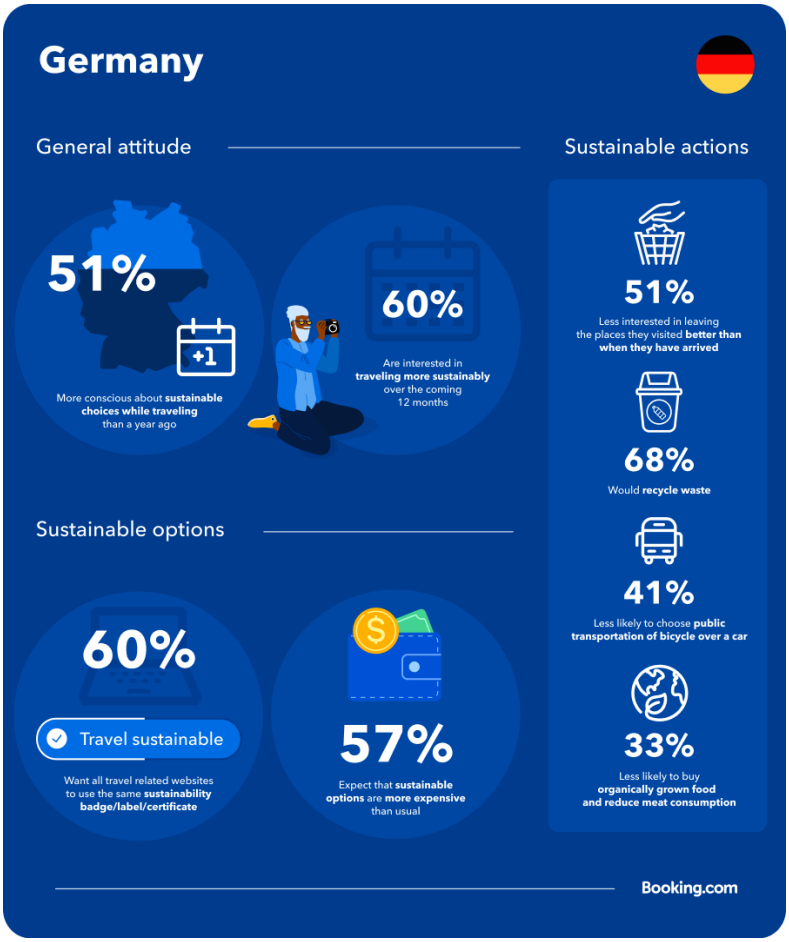
In contrast, German tourists show growing awareness, with 60% reporting increased consciousness of sustainability compared to a year ago, and 66% wanting more sustainable options from travel companies. However, they are more skeptical about sustainable labels and find eco-friendly choices often too expensive, despite being more inclined to travel closer to home for sustainability reasons (Booking.com, n.d.).

US travelers, on the other hand, display a lower emphasis on sustainability, with only 31% planning to use public transport for sightseeing, and 37% traveling outside peak season to avoid overcrowding. 44% of US travelers express skepticism toward sustainability labels,

reflecting a hesitation to fully embrace sustainable travel. Similarly, UK tourists show a somewhat indifferent attitude, with 76% considering sustainable travel less important than the global average. They are also less likely to filter for properties with sustainable certifications, with 48% showing disinterest, and 47% doubting the credibility of sustainable labels (Booking.com, n.d.).

This comparison highlights that while Mexican and German tourists demonstrate a stronger commitment to sustainable travel, US and UK travelers remain more hesitant, especially regarding the trust and cost of sustainable options (Booking.com, n.d.).

Figure 8 - Germany Sustainable Travel Habits



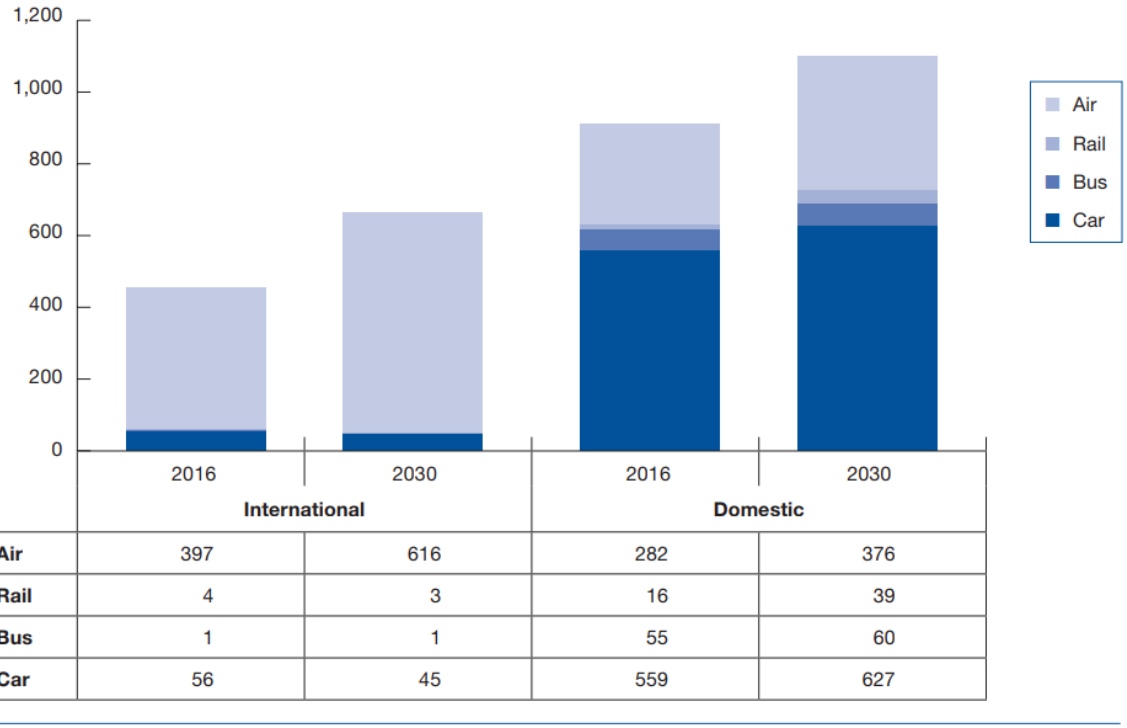
Source: Booking.com. (n.d.). Sustainable travel habits: How travelers are changing their habits (2024)

2.3.1 Carbon Footprint Impact of Tourist Transport Choices

The UNWTO and ITF, in a joint study (Transport-related CO_2 Emissions of the Tourism Sector Modelling Results, 2019), highlight the significant impact of tourism on global CO_2 emissions, particularly from transport. According to their assessment, transport accounts for 75% of these emissions. The report provides data on CO_2 emissions per passenger kilometer for various modes of transport, including cars, buses, rail, and air travel. Air travel is identified

as a significant contributor. The study projects trends up to 2030, emphasizing tourism's growing contribution to global emissions. The report's call for stakeholder involvement is crucial because, without industry-wide adoption of sustainable practices, this projected growth could undermine global climate goals. This collaborative action is essential for aligning the tourism sector with international climate objectives (Transport-related CO_2 Emissions of the Tourism Sector Modelling Results, 2019).

Figure 9 - Overview of transport-related emissions from domestic and international tourist arrivals by mode of transport: air, rail, bus and car, 2016 and 2030 (Mt of CO_2)



	2016	2030	2016	2030
	International		Domestic	
Air	397	616	282	376
Rail	4	3	16	39
Bus	1	1	55	60
Car	56	45	559	627

Notes: New tourism-related transport demand model developed for this study.

Source: Transport-related CO_2 Emissions of the Tourism Sector Modelling Results (2019)

To illustrate the varying CO_2 impacts of transport modes within tourism, the Figure 9 from the "Transport-related CO_2 Emissions of the Tourism Sector Modelling Results, 2019" provides a clear overview that captures the carbon emissions associated with different transport modes such as air, rail, bus, and car for both domestic and international tourism. This figure presents current emissions data and projections up to 2030, offering a clear, side-by-side comparison of each mode's contribution to the tourism sector's carbon footprint. By displaying the distinct impact of each transport choice, also highlights the importance of sustainable travel behavior, reinforcing the section's focus on how tourist decisions directly influence CO_2 emissions. This critical tool illustrates the need for low-carbon travel alternatives and aligns with broader sustainability goals, making it an essential component of my analysis (Transport-related CO_2 Emissions of the Tourism Sector Modelling Results, 2019).

Cascetta and Henke (2023) identify several key challenges that must be addressed to achieve sustainable mobility. One of the primary obstacles is the decarbonization of transport, which necessitates a significant shift away from fossil fuels. This transition requires substantial investments in alternative energy sources and the development of supporting infrastructure. Another challenge is managing the transition to self-driving vehicles.

While autonomous vehicles offer exciting opportunities for innovation in transportation, they also bring forth safety concerns, ethical dilemmas, and the potential for increased congestion if not properly managed. Additionally, the emergence of new mobility services, such as ride-sharing and on-demand transport, presents both opportunities for enhancing sustainability and concerns regarding equity and accessibility. These services may disrupt existing public transport systems, advocating for an accurate assessment of their effects (Transport-related CO_2 Emissions of the Tourism Sector Modelling Results, 2019).

Finally, political and social factors play a crucial role in the implementation of sustainable mobility solutions. Navigating complex political landscapes and addressing social equity issues is essential to ensure that the benefits of sustainable transport are equitably shared, particularly among vulnerable populations who require access to affordable and sustainable transportation options (Transport-related CO_2 Emissions of the Tourism Sector Modelling Results, 2019).

2.3.2 Sustainable Tourism Initiatives: Exploring Certifications Practices

As the tourism industry grapples with the urgent need for sustainability, a range of initiatives have emerged to promote responsible travel practices. Sustainable tourism certifications play a crucial role in guiding stakeholders ranging from accommodation providers to transportation services toward more eco-friendly operations (Costa, Rodrigues and Gomes, 2019).

These programs not only help reduce the environmental impact of tourism but also enhance social and economic benefits for local communities. By establishing clear standards and best practices, certifications such as Green Globe, EarthCheck, and the Global Sustainable Tourism Council empower businesses to adopt sustainable practices while attracting more environmentally conscious travelers (Costa, Rodrigues and Gomes, 2019).

The integration of sustainability into tourism practices is vital for the sector's long-term viability, emphasizing the need for collaboration among industry players to achieve meaningful change (Alonso-Muñoz et al., 2022).This section explores the landscape of sustainable tourism initiatives, discuss their effectiveness, challenges, and the overall contribution to promoting responsible tourism.

Green Globe Certification is one of the world's first sustainability certification programs for tourism, established in 1993. It offers a comprehensive framework for sustainable practices, assessing criteria like energy efficiency, water conservation, and waste management. With over 500 members globally, Green Globe is recognized for its robust standards and has certified notable establishments like the Hilton Los Cabos in Mexico for reducing energy and water usage by over 20% (Green Globe, 2024).

EarthCheck Certification, launched in 1987 in Australia, is one of the oldest and most rigorous sustainability programs, focusing on environmental, social, and economic sustainability in tourism. EarthCheck helps members reduce emissions and resource consumption, with success stories such as the Atlantis Hotel in Dubai, which achieved a 15% reduction in water consumption through EarthCheck's guidance. Both programs drive substantial improvements, helping tourism operators achieve recognized sustainability standards (EarthCheck, 2024).

The Transportation Climate Initiative (TCI) is a collaborative effort among U.S. states to reduce greenhouse gas emissions from the transportation sector, launched in 2010. Focusing on initiatives like electric vehicle expansion and public transit improvement, TCI aims to create low-carbon transportation options. A success case includes Maryland's participation, which led to substantial investment in electric vehicle infrastructure and reduced emissions from state transportation by over 30% since TCI's launch. While not exclusively for tourism, TCI's initiatives support sustainable tourism efforts by promoting greener travel options (About Us | Transportation and Climate Initiative, n.d.).

The Eco-Wanderer campaign by Europe's Famous Hostels, which inspired my thesis idea on sustainable travel choices, promotes eco-friendly exploration across Europe. Offering discounts to Interrail and Eurail pass holders, this initiative rewards travelers for selecting trains over planes, highlighting rail travel's reduced carbon footprint. Supported by the European Travel Commission's 2021 Year of Rail, Eco-Wanderer lets participants calculate and track CO_2 savings through an online tool, redeemable for hostel discounts across 19 countries. Additional FlixBus incentives expand these options for sustainable travel, making it easier and more appealing for modern travelers to choose lower-impact journeys (Support, 2024).

3. MATERIALS AND METHODS

My research employs a mixed-methods approach, combining quantitative and qualitative techniques. The qualitative aspect includes a literature review and on-site observations of the hostel in Budapest. Working as a receptionist in the hostel for two and a half year, I was able to observe the tendencies of the tourism business as well as guest behavior from an insider's perspective.

The quantitative analysis involves a questionnaire to collect primary data on tourists' travel behaviors and carbon footprint awareness. My thesis questionnaire has 17 questions (14 multiple choice and 3 short answers) subdivided into five groups to collect: demographic information, travel details, carbon footprint awareness, travel behavior, and sustainability initiatives.

With the professor orientation, I carefully choose the questions of the questionnaire in order to achieve the thesis goals and gain valuable insights of awareness and actions of tourists to the environment.

The use of a questionnaire was also essential for gathering first-hand information from tourists on their transportation choices, sustainability perceptions, and awareness of environmental impacts.

I applied the questionnaire in Budapest – Hungary, as for the reason of the city being famous as a tourist destination. The chosen company was “Maverick Urban Lodge Hostel”, located in the ninth district, near to the Budapest city center, also member of the European Famous Hostel Network, well known for its sustainable practices. Although, the hostel facility has a range of different rooms, dormitories and private options, that attracts a different style of tourist, the study might not indicate the preference of all tourist but those who prefer to stay in hostel.

Using the Google Forms tool to collect on-site data, I was able to reach participants from different nationalities, which had Budapest as travel destination. To facilitate the communication channel between the research and the targeted participants, I used the company’s WhatsApp group messages, which all guests were invited to join during the check-in time.

The management team was happy to let me advertise the research survey using the hostel's facilities and communication channel for my research. The questionnaire was posted daily in the group chat over a two-month period between July and August.

I select this timeframe strategically, as most guests visiting Budapest during this period were motivated by general travel interests rather than attending specific events like the Sziget

Festival, Formula 1 races, and other major concerts. This made sure that the survey response reflects the general travel patterns and carbon footprint in the minds of the targeted people without distortions of event based travel demand.

For data analysis, I chose Microsoft Excel Software as the primary tool to organize the questionnaire responses, to calculate the carbon footprint and create charts and tables.

The carbon footprint calculation was an extra effort for better understanding of the impacts of carbon dioxide emissions on travel patterns. For these calculations, I assumed that guests departed from their capital cities from origin country provided in the questionnaire, as for the complexity and challenges on this matter. This approach made me able to standardize the basis of the calculations and estimate emissions from their trip.

For air travel distances, I chose the Airmilescalculator website, which uses Vincenty's formula to calculate distances between latitude and longitude points on an ellipsoidal Earth model. I chose this method to ensure accuracy, as carbon footprint values significantly depend on the travel distance a routes taken (Airmiles Calculator, n.d.).

For train distances, I referred to various websites, including Rome2Rio, Rail Europe, Raill.cc, and Trainline. Given the numerous train routes available, I selected the distances of the most commonly taken routes for consistency (Rome2Rio, n.d.) (Rail Europe,n.d.) (rail.cc, n.d.) (Trainline, n.d.).

For car travel, I used Google Maps to estimate distances based on the most probable driving routes to Budapest. To calculate the carbon footprint of the travels, I used emission factors from the Bilan Carbone (Base Empreinte) developed by the French Environment and Energy Management Agency (ADEME), in accordance with the GHG Protocol, this method is a reliable framework for calculating greenhouse gas emissions across different transport modes and for assessing the carbon footprint of any kind of activities (ADEME, n.d.) (Greenhouse Gas Protocol, n.d.)

To present and support my findings on emission values and participant choices, I used pie and bar charts, which effectively illustrated key patterns such as the preferred modes of transportation among guests.

These visualizations were essential for highlighting the values in CO_2 emissions tied to different transportation modes. Take in consideration the absence of the specific route and exact mode of transportation from on point to another, I only have an initial point of the trip and the final destination Budapest I created hypothetical scenarios based on CO_2 emissions for the largest groups of participants from specific regions. This approach provided a realistic overview of potential emissions and enabled clearer interpretation of the data.

4. RESULTS AND DISCUSSIONS

This section presents the findings from data collected through a survey of 74 tourists at a Budapest hostel. The questionnaire was designed to capture demographic details, travel habits, awareness of carbon footprint impacts, and attitudes toward sustainable travel. Given Budapest's role as a European travel focal point, the international diversity of participants provides insights into typical tourist behaviors and awareness of low-carbon travel options.

The collected data is used as a basis for investigating how much tourists comprehend about carbon footprints or the effect that tourist choices have on emissions. In order to correct common gaps in specific travel data, hypothetical cases were developed for the calculation of carbon emissions. This analysis also aligns to the subject matter explored in the literature review such as carbon footprint importance, transport emissions, and sustainable travel behavior to evaluate the current measures in sustainable travel.

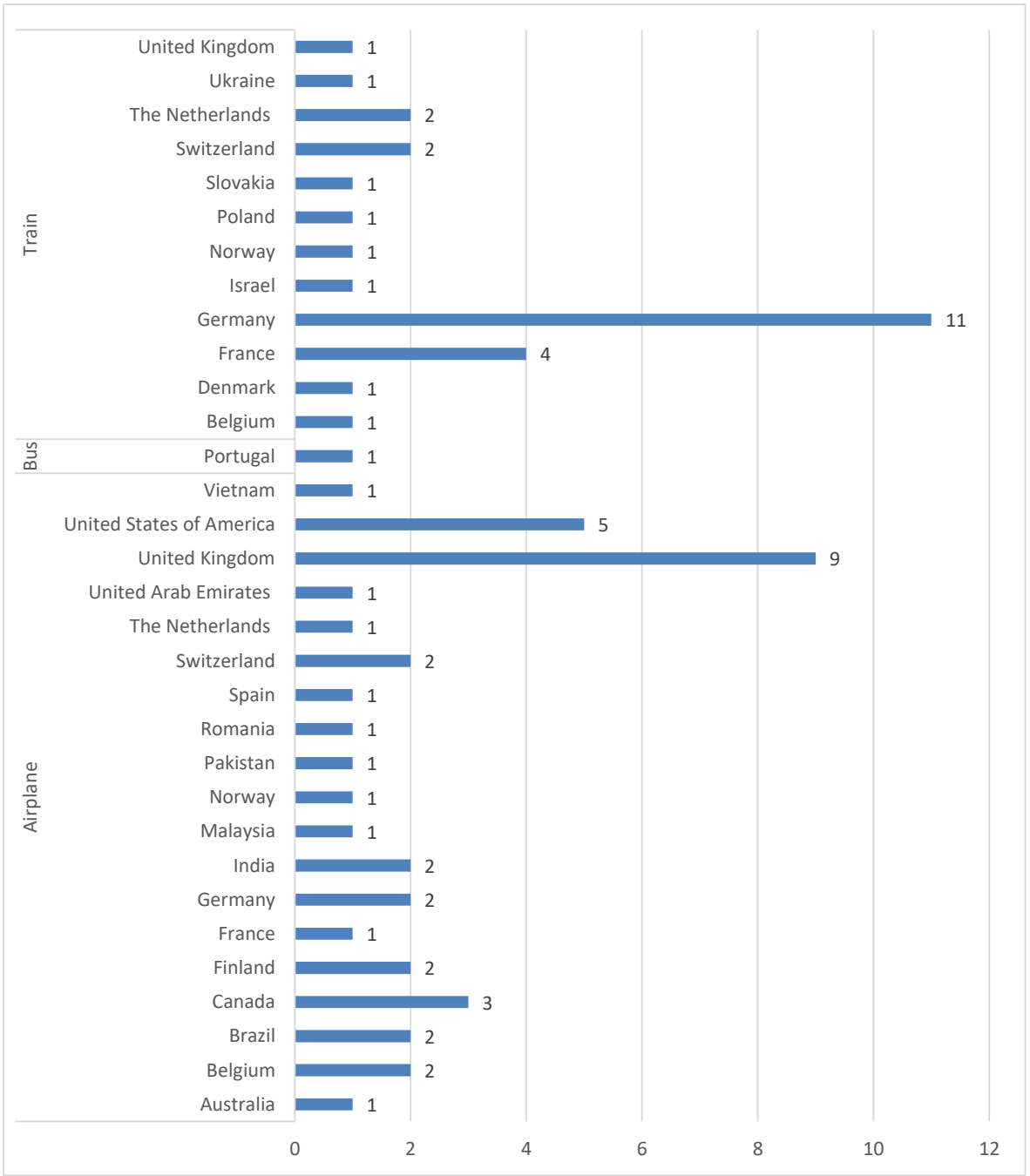
Figure 10 illustrates the results from the first question, "What kind of transportation did you use on the way to Budapest?" (Select all that apply), also illustrates the question number 15 regarding the "Country of Origin". A total of 67 answers were considered, representing five different continents. It is important to note that question 01 was designed to allow more the one answers due to the different geographic characteristics of the guests' journeys. As a result, many respondents may have utilized more than one mode of transportation to reach Budapest.

Notably, the analysis excluded 7 responses because reported transportation methods were unrealistic, such as guests claiming to have traveled by train from countries like Australia or Canada. Consequently, Figure 10 presents only the primary mode (first mode) of transportation selected by the guests, offering a more accurate illustration of their travel choices.

The data reveals significant insights into the transportation modes utilized by tourists traveling to Budapest. The predominant choices among respondents were airplane (39 travelers) and were train (27 travelers), indicating a clear preference for these modes. Train travel emerged as the primary option for many European tourists, particularly those from Germany, with 11 travelers opting for this mode. Other notable countries included France (4 travelers), and The Netherlands and Switzerland (2 travelers each).

In fact, airplane travel was the most significant mode for tourists from non-European countries. The largest group of air travelers emerged from the United Kingdom (9 travelers), followed by visitors from the United States (5 travelers) and Canada (3 travelers).

Figure 10 - Demographic Information: Travelers by Transportation Primary Type



Source: Own editing based on Thesis Questionnaire (2024)

Figure 11 shows the pie chart representing the responses to the second question of my thesis questionnaire, the specific question was: "If you traveled by airplane, did you consider the carbon footprint when booking your flight?" A total of 74 participants responded, providing insight into their decision-making process regarding sustainable travel.

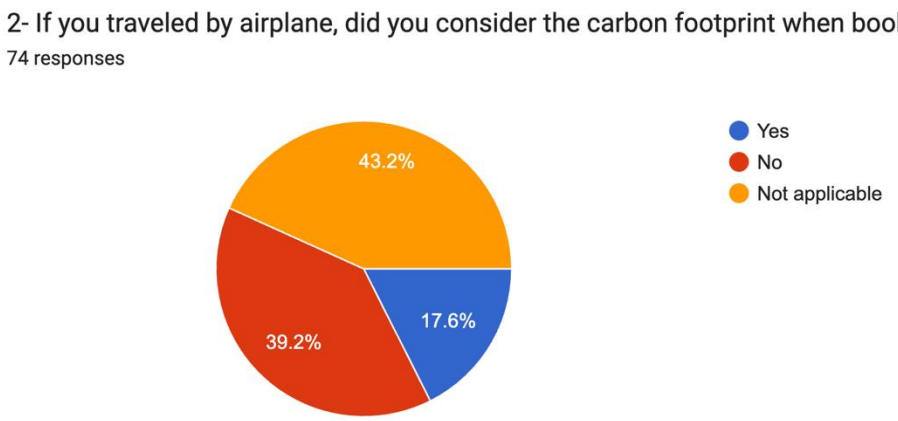
The largest group of respondents, 43.2%, indicated that the question was "Not applicable" to them, suggesting that they did not travel by airplane. This group could represent travelers who used other modes of transportation, such as trains or buses, or those who may

not have traveled long distances.

Meanwhile, 39.2% of respondents, a significant portion, answered "No", implying that they did not consider the carbon footprint when booking their flight. This highlights a gap in awareness or prioritization of environmental impact among these travelers.

In contrast, only 17.6% of participants responded "Yes", showing that a minority considered the carbon footprint when selecting their transportation mode.

Figure 11 - Carbon footprint Awareness



Source: Own editing based on Thesis Questionnaire (2024)

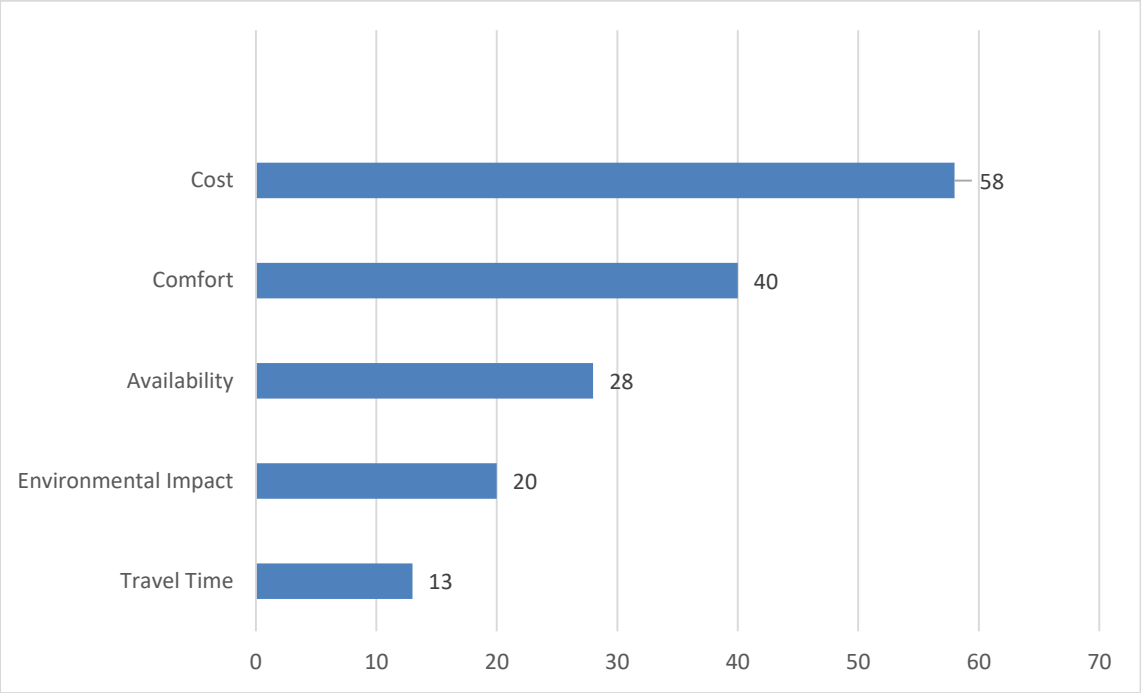
Note: All 74 responses were considered for this graphic.

Figure 12 illustrate the bar graph representing the responses to the third question of my thesis questionnaire, the specific question was: “What influenced your choice of transportation?”. A total of 74 participants responded, the results highlights “Cost” as the most significant factor, with 58 respondents choosing it as a significant influence. This is followed by “Comfort”, chosen by 40 respondents, indicating that time efficiency is also a major consideration.

For “Availability” ranked as third, with 28 respondents prioritizing the access to transportation options. Furthermore "Environmental impact" was selected by 20 respondents, suggesting that although important, it is secondary to factors like cost and time. Only 13 respondents identified “Travel Time” as an influencing factor, reflecting a relatively lower priority placed on sustainable choices.

These findings suggest that even though cost and comfort are major factors, environmental concern plays a lesser role in tourists transport choices. The collected information is relevant for identifying barriers concerning sustainable travel behavior promotion and can be used for forming suggestions concerning the tourists’ consciousness.

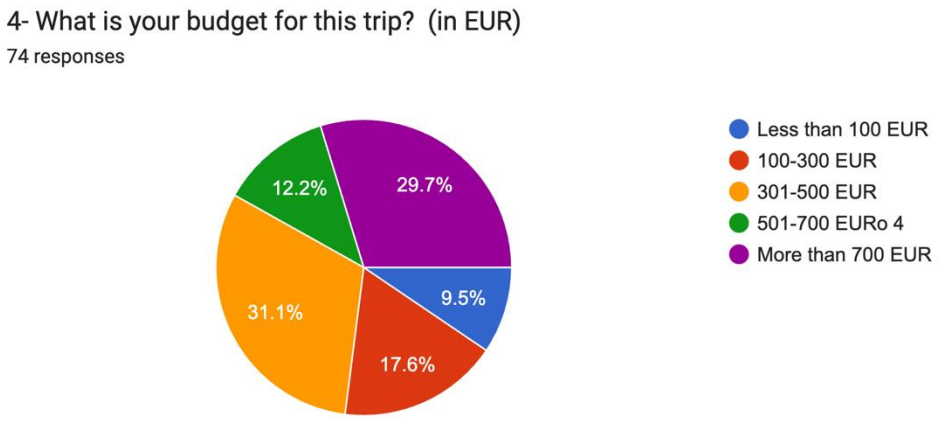
Figure 12 - Influences for Transportation Choice



Source: Own editing based on Thesis Questionnaire (2024)

Figure 13 illustrates the budget distribution among 74 hostel tourists in Budapest. The analysis reveals that 29.7% of respondents allocated more than 700 EUR, representing the largest segment, while 31.1% budgeted between 301-500 EUR. Additionally, 17.6% planned to spend 100-300 EUR, 12.2% budgeted between 501-700 EUR, and 9.5% allocated less than 100 EUR, the smallest segment. This distribution is significant as it indicates a substantial portion of tourists (73%) possess a budget exceeding 300 EUR, suggesting they may have the financial flexibility to opt for sustainable transportation options, even if these choices come at a higher cost. Conversely, the 27.1% of tourists with budgets under 300 EUR may face some restriction in selecting more sustainable yet potentially pricier transportation methods. Understanding these budget restriction is crucial for assessing how they might influence tourists' decisions between more sustainable, although more expensive, transportation options versus cheaper alternatives that have a higher carbon footprint.

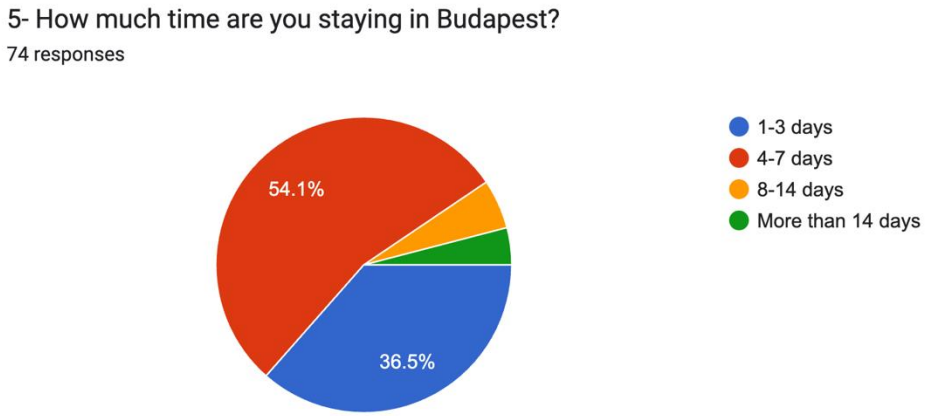
Figure 13 - Travel Information: Budget



Source: Own editing based on Thesis Questionnaire (2024)

Figure 14 shows the pie chart that illustrates the responses to the question about the duration of tourists' stays in Budapest. The findings indicate that 36.5% of respondents stayed for 1-3 days, while a majority, 54.1%, reported stays of 4-7 days. There are also small segments for those staying 8-14 days and more than 14 days. The amount of tourists staying for 4-7 days suggests that their length of stay may significantly influence their transportation choices and overall carbon footprint. Understanding these patterns is essential for developing effective strategies to promote sustainable travel behaviors among visitors in Budapest. Notably, this question was suggested by the hostel for further analysis, highlighting its relevance in understanding tourist behavior.

Figure 14 - Travel Information: Staying Time

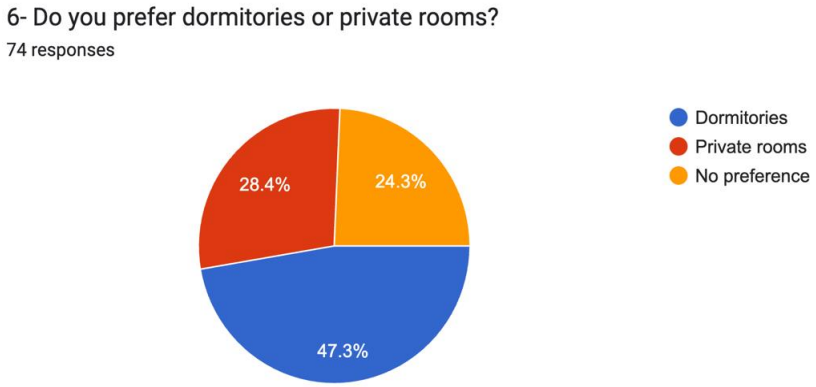


Source: Own editing based on Thesis Questionnaire (2024)

Based on Figure 15 bellow, which represents question number 6 of my thesis questionnaire, the pie chart illustrates the accommodation preferences of 74 survey respondents

regarding their choice between dormitories and private rooms. The results indicate that 47.3% of respondents prefer dormitories, while 28.4% opt for private rooms, and 24.3% have no preference. Dormitories, favored by the majority of respondents, typically have a lower person carbon footprint due to shared resources, space, and energy consumption. The high preference for dormitories (47.3%) suggests that many tourists visiting Budapest hostels may be making more environmentally sustainable accommodation choices, even if not intentionally. Additionally, the respondents with no preference (24.3%) highlighting an opportunity for proper education and incentives to guide travelers towards sustainable options. This question was required by the hostel for further analysis.

Figure 15 - Travel information: Room Preference

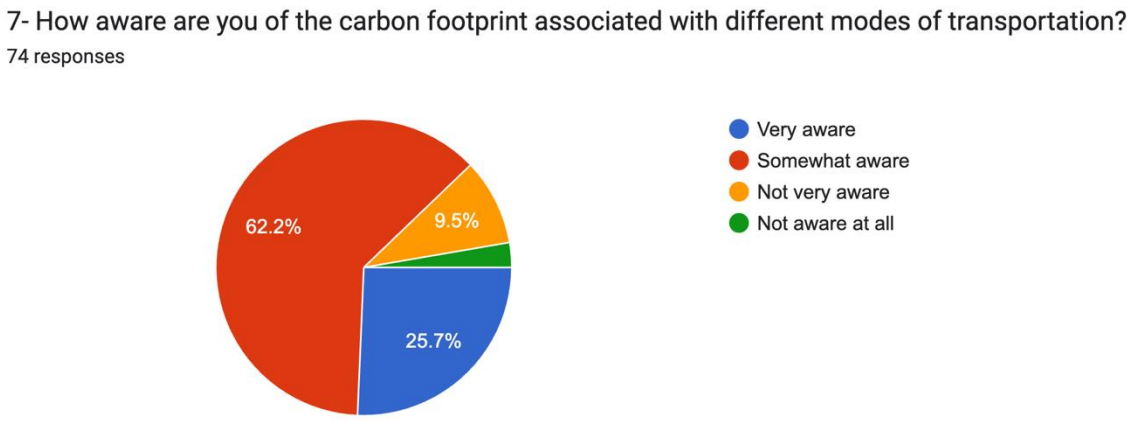


Source: Own editing based on Thesis Questionnaire (2024)

The pie chart in Figure 16 illustrates the level of awareness among respondents regarding the carbon footprint associated with different modes of transportation. This data is integral to my study on sustainable travel behavior and carbon footprint climate impact.

The chart reveal that 62.2% of respondents are somewhat aware of the carbon footprint of transportation, while 25.7% are very aware of its implications. In contrast, 9.5% of respondents have limited awareness, and a small portion, 2.7%, are completely unaware of the carbon footprint related to transportation. These findings suggest that while a majority of tourists possess some level of awareness, there remains significant potential for enhancing understanding and promoting sustainable travel behaviors.

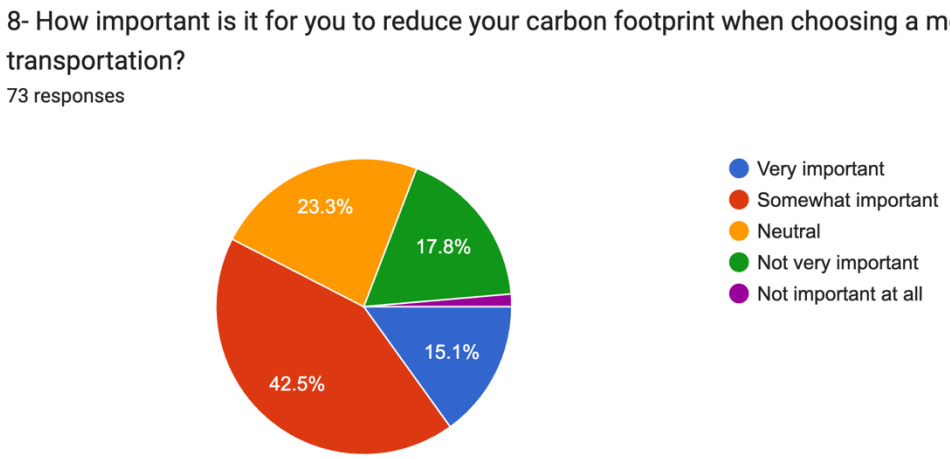
Figure 16 - Carbon Footprint Awareness by Different Transportation Types



Source: Own editing based on Thesis Questionnaire (2024)

The pie chart in Figure 17 of my thesis questionnaire, titled "How important is it for you to reduce your carbon footprint when choosing a mode of transportation?" presents the responses from 73 participants. The chart is divided into five segments, showing that 42.5% of respondents find it very important to reduce their carbon footprint, while 23.3% consider it somewhat important, 15.1% are neutral, 17.8% find it not very important, and 1.4% see it as not important at all. This data indicates that a substantial portion of respondents (42.5%) highly prioritize carbon footprint reduction in their transportation choices, demonstrating a strong tendency toward sustainable travel behaviors. The combined responses of "Very important" and "Somewhat important" reveal that 65.8% of participants consider carbon footprint reduction a priority, while only 19.2% view it as unimportant. These findings suggest a generally positive attitude toward sustainable travel among hostel tourists in Budapest, reflecting a growing awareness of environmental impact.

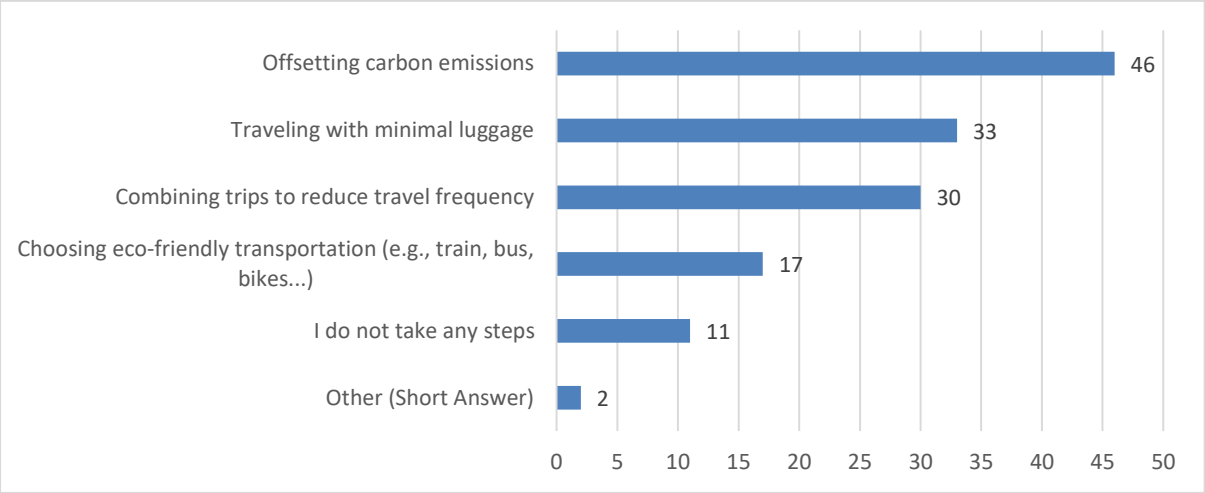
Figure 17 - Carbon Footprint Consciousness



Source: Own editing based on Thesis Questionnaire (2024)

According to the Figure 18, displacing the answers from the Question 9: “Do you take any steps to reduce your carbon footprint when traveling? (Select all that apply)”, A total of 74 participants responded, the results specify “Offsetting carbon emission” as most significant action taken, with 46 respondents. This choice highlights an awareness of carbon-offset programs and shows willingness to address travel-related emission. This is followed by “traveling with minimal luggage”, chosen by 33 respondents, suggesting that many travelers recognize that reducing luggage weight can lower their carbon footprint. For the option “Combining trips to reduce travel frequency” ranked as third, with 30 respondents. Where reflects and understating that less trips mean less emission. “Choosing eco-friendly transportation” was another option with 17 respondents reflecting a preference for lower-emission travel method when available. Only 11 respondents indicated that they do not take any steps to reduce their carbon footprint, showing that the majority are at least somewhat engaged with sustainability practices. "Other" was chosen by 2 respondents, though no specific steps were provided, indicating there may be additional unique actions taken that were not covered in the listed options.

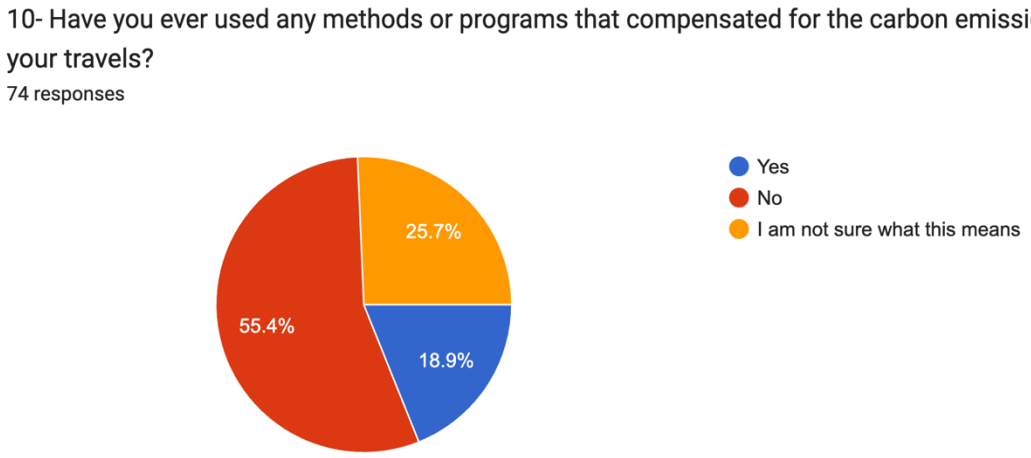
Figure 18 - Steps to Reduce Carbon Footprint



Source: Own editing based on Thesis Questionnaire (2024)

In Figure 19 of my thesis questionnaire, I explored the question, "Have you ever used any methods or programs that compensated for the carbon emissions from your travels?" with responses from 74 participants. The chart shows that only 18.9% of respondents have engaged in carbon offsetting methods or programs, while 55.4% have not, and 25.7% are unsure about what this concept entails. This data provides valuable insight into tourists' awareness and engagement with sustainable travel practices. With the majority either not participating or uncertain about carbon offsetting, we can also deduce that visible options or programs for reducing carbon footprints may not be available or promoted to travelers.

Figure 19 - Carbon Footprint Programs Knowledge



Source: Own editing based on Thesis Questionnaire (2024)

The pie chart in Figure 20 presents the responses to the question: "Would you be interested in learning more about the Eco-Wanderer program, which promotes eco-friendly

travel practices?" The results, based on 74 responses, are divided evenly between "Yes" and "Maybe," each accounting for 37.8% of the total. Meanwhile, 24.3% of respondents indicated "No" interest in learning more about the program. This suggests that there is considerable potential to engage tourists in eco-friendly travel initiatives, with over 75% of either the respondents open to or considering further information about sustainable travel practices.

Figure 20 - Eco-Wanderer Program Awareness

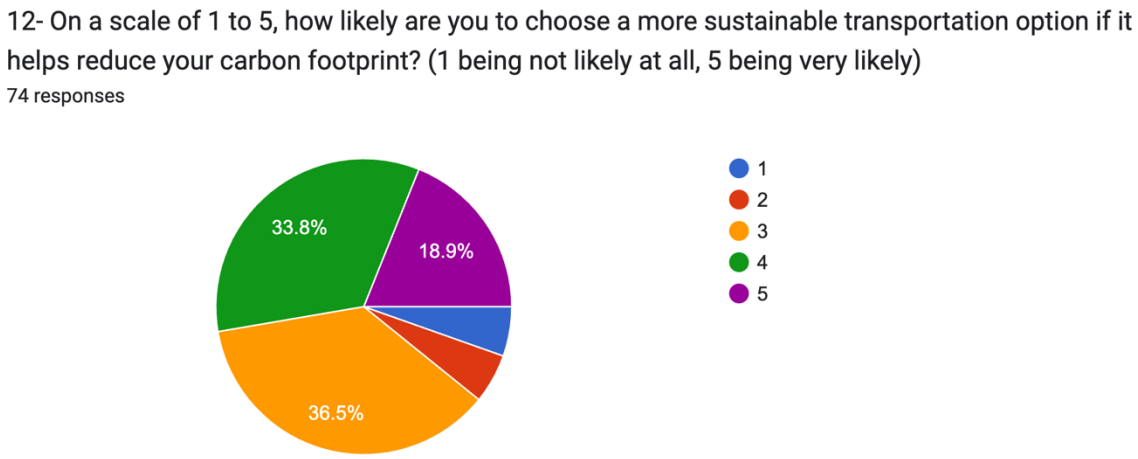
Source: Own editing based on Thesis Questionnaire (2024)

Figure 21 (Question 12) of the questionnaire assesses the likelihood of tourists in Budapest hostels opting for sustainable transportation to reduce their carbon footprint. The respondents (74 in total) were asked to rate their likelihood on a scale of 1 to 5, with 1 being "not likely at all" and 5 being "very likely.

The results show that the largest group (36.5%) rated themselves at a 3, indicating moderate likelihood. Additionally, 33.8% of participants gave a rating of 4, suggesting a relatively high inclination toward choosing sustainable transportation options. Meanwhile, 18.9% of respondents were very likely to choose sustainable options (rating of 5). On the lower end, only a small portion selected the least likely option, with 1.4% choosing 1 and 9.5% selecting 2, indicating a minority with low likelihood to change their transportation habits for sustainability.

This data suggests that a significant number of tourists are open to considering more sustainable travel options to help reduce their carbon footprint, though there is room for further encouragement.

Figure 21 - Sustainable Transportation Preferences

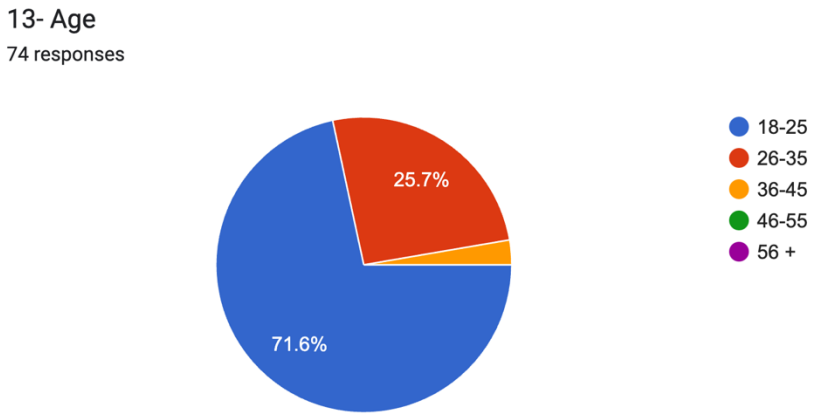


Source: Own editing based on Thesis Questionnaire (2024)

Figure 22 (Question 13) of the thesis questionnaire explores the age distribution of respondents in the study assessing sustainable travel behavior and carbon footprint climate impact among tourists at a Budapest hostel. With 74 total responses, the data reveals that the majority of participants, 71.6%, fall within the 18-25 age group. This is followed by 25.7% of respondents who are between 26-35 years old. A very small portion of respondents, 2.7%, is in the 36-45 age range. Notably, there were no responses from individuals aged 46-55 or 56 and above.

This data highlights that the survey predominantly captures the perspectives of younger tourists, particularly those under 35, which may have implications for interpreting sustainable travel behaviors and preferences within this demographic.

Figure 22 - Demographic Information: Age



Source: Own editing based on Thesis Questionnaire (2024)

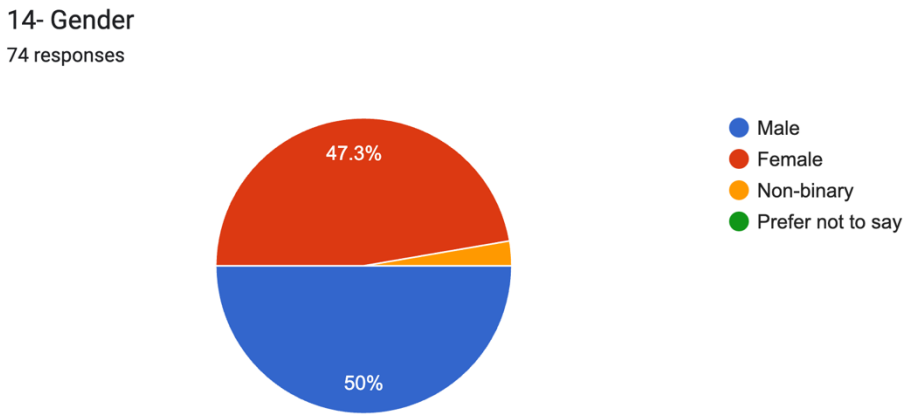
Figure 23 (Question 14) of my thesis questionnaire presents the gender distribution of respondents in my study on sustainable travel behavior and the impact of transportation choices on carbon footprints among tourists at a Budapest hostel. Out of the 74 responses, 50% identified as male, and 47.3% identified as female. Additionally, 1.4% of respondents identified as non-binary, while another 1.4% preferred not to disclose their gender.

In question 16 of the thesis questionnaire, respondents provided few suggestions for considering carbon footprint reduction during travel. Many emphasized the need for accessible information about carbon emissions associated with different transportation options, advocating for clear communication during the booking process and relatable comparisons, such as equating emissions to everyday energy usage.

A common theme was the desire for affordable public transportation, especially for younger travelers, as cost often influences travel decisions, leading many to prioritize budget-friendly options over sustainability. Participants also highlighted the importance of dining at locally established restaurants that source ingredients locally as a way to reduce carbon footprints. Additionally, there was a call for better education on the environmental impacts of various travel choices, including the benefits of public transport.

Respondents suggested implementing incentive programs for carbon offsetting, clearer labeling of carbon footprints on transportation options, and offering discounts for choosing more environmentally friendly travel methods. Overall, the responses indicate a desire for greater awareness and accessibility of sustainable travel options, along with systemic changes in pricing and information dissemination to support eco-friendly choices.

Figure 23 - Demographic Information: Gender

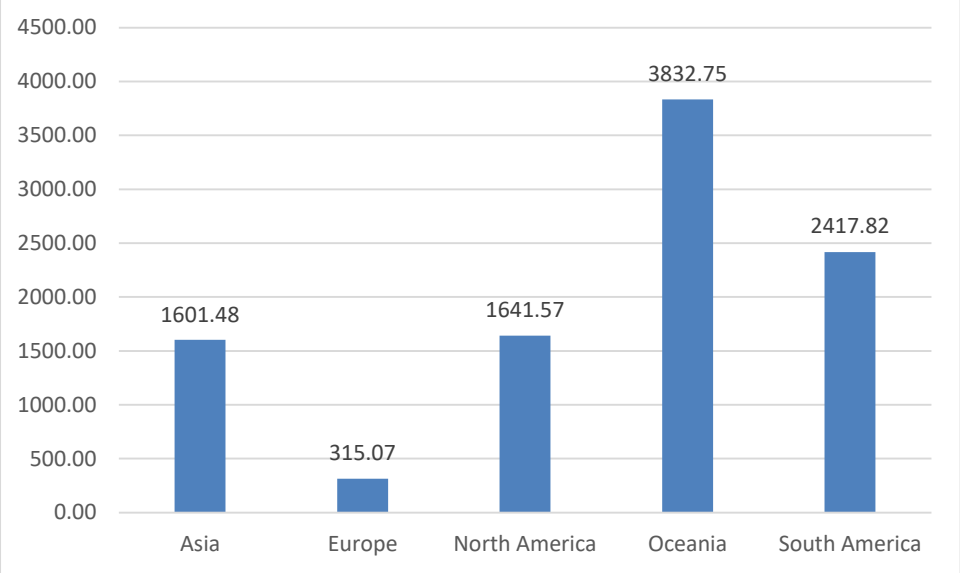


Source: Own editing based on Thesis Questionnaire (2024)

Figure 24 shows the average carbon footprint of travelers by airplane in kgCO_2e per

continent calculated from 39 participants of the survey who travelled to Budapest. The emission and so the carbon footprint is related to the distance.

Figure 24 - Average Carbon Footprint (kgCO_2e) by Continent



Source: Own editing based on Thesis Questionnaire (2024)

In Table 2 – Airplane Travelers Quantity by Continent I dispose those participants also by country, as the distance is essential to identify the emission factor used on the calculation of the average emission.

I performed the carbon footprint calculation based on the values presented in the Table 2. In order to be able to calculate the average CO_2 emission for each continent presented in the Figure 24, first I multiplied with the number of participant's of each country and respective emission factor from their travel distance and then divided it by the number of participants of each continent.

By using this metric, I was able to identify the average kgCO_2e emission (carbon footprint) per passenger/continent. It resulted in 1601.48 kgCO_2e for travelers coming from Asian countries, 315.07 kgCO_2e from European countries, 1641.57 kgCO_2e from North America, 3832.75 kgCO_2e from Oceania and 2417.82 kgCO_2e from South America.

The data suggest a high average emission from long distance travelers are responsible for higher emission of CO_2 in the atmosphere, as per discussed previously in the literature review of this thesis.

For deeper investigations of these amounts among different types of transportation, I have performed other calculation hypothetically comparing Germany (13 participants) and United Kingdom (11 participants) since out of the 74 total respondents, significant proportion came from those places.

Table 2 - Airplane Travelers Quantity by Continent and Country

Continent and Country	**Participants**	**Air Distance** (km)	**Emission Factor** (kg CO_2e per passenger/km)
Asia	**6**		
India	2	5365	0.122
Malaysia	1	9198	0.122
Pakistan	1	4706	0.168
United Arab Emirates	1	4031	0.142
Vietnam	1	8069	0.126
Europe	**22**		
Belgium	2	1128	0.118
Finland	2	1459	0.118
France	1	1244	0.118
Germany	2	688	0.160
Norway	1	1481	0.118
Romania	1	643	0.160
Spain	1	1974	0.118
Switzerland	2	876	0.160
The Netherlands	1	1144	0.118
United Kingdom	9	1449	0.118
North America	**8**		
Canada	3	6774	0.115
United States of America	5	7334	0.115
Oceania	**1**		
Australia	1	15717	0.122
South America	**2**		
Brazil	2	10258	0.118

Note: Only 39 travelers – having Airplane as their first choice.

Source: Own editing based on Thesis Questionnaire (2024)

For instance, I have chosen the transportation types: car, airplane and train for this comparison. On the Table 3, it is possible to access the emission factors for these model types and the distances.

Table 3 - Germany and UK Travelers by Different Transportation Mode

Country	**Transport Type**	**Distance to Budapest (km)**	**Emission factor**
Germany	Airplane	688	0.160*
	Train	687	0.067**
	Car	870	0.259***
United Kingdom	Airplane	1449	0.118*
	Train	1450	0.075**
	Car	1726	0.259***

* kg CO_2e per passenger/km, ** kg CO_2e per person/km, *** kg CO_2e per vehicle/km

Source: Own editing based on Thesis Questionnaire (2024)

I performed the carbon footprint calculation based on the values presented in the Table

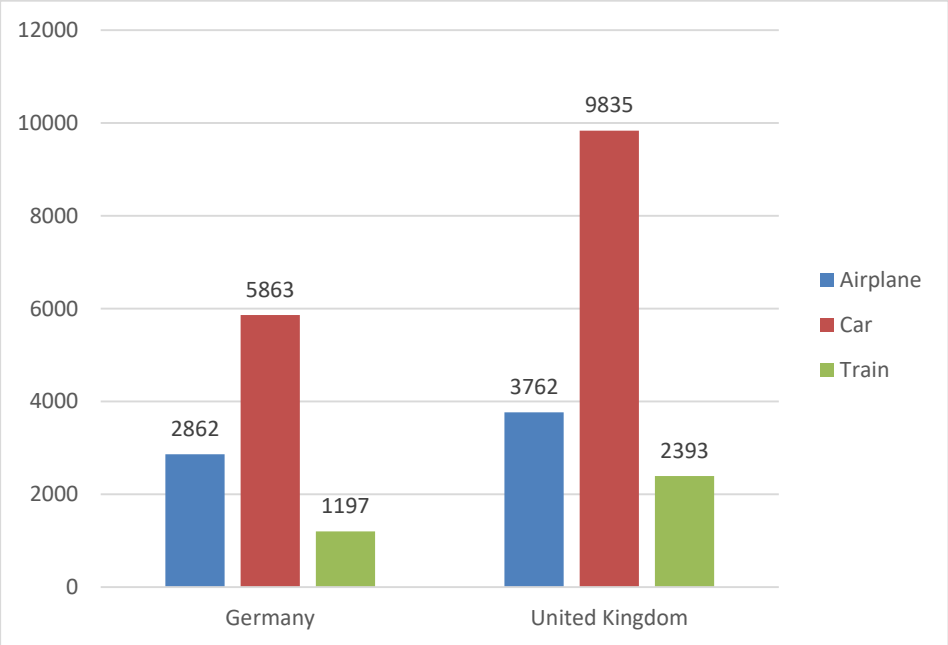
3. In order to be able to calculate the carbon footprint for different transportation types presented in the Figure 25, I had first to multiply the number of participants of each country and respective emission factor from their travel type.

As the emission factor has different units, in this case I use the sum of emissions considering the total number of participants coming from each place: Germany (13 participants) and United Kingdom (11 participants). In both of the scenarios, I chose the capitals Berlin and London as the starting point of their trip to Budapest.

The graph suggests a higher emission from traveler that chose cars as the transportation type. However, it is essential to emphasize that the calculations considers one passenger/per car. If the car was full, the emission would be 4-5 times lower. On the other hand, in the emission calculation from flight we assume that the airplane is full of passengers.

In parallel Train, emissions are substantially lower than Airplane and Car, which indicates a good option in sustainable travel practices. However, as I mentioned for the other types, it is important to note the Train capacity, energy source, and other technologies employed to have a better understanding to choose the best solution.

Figure 25 - Hypothetical Calculation of Carbon Footprint (kgCO_2e) by Country and Transport Type



Source: Own editing based on Thesis Questionnaire (2024)

5. CONCLUSIONS AND PROPOSALS

In this particular research, I intended to assess the impacts of carbon footprints of the tourists' transportation choices traveling to Budapest and evaluate potential of options to reduce the carbon footprint through more sustainable alternatives. By analyzing emissions related to different type of transport, comparing the carbon footprint between air and rail transportation, and examining tourists' awareness of their carbon environmental impact, I aimed to contribute to the understanding of how to promote more sustainable tourism practices.

As a result of my investigation, there is visible preference for air travel among tourists arriving in Budapest, which agrees to the literature review that indicates of increasing demand for aviation. This preference explain that for visitors coming from outside Europe, who have to cover long distances, where flights are often the only possible way to reach Budapest. While being much more environmentally friendly, trains are not possible for long distances and intercontinental travel. However, this reliance on air travel for these longer distances results in a very large environmental impact, as air travel generates so much more CO_2 than other forms of transportation over such distances.

Although, the data also highlight the applicability and appeal of train travel within Europe, supported by Budapest's strategic location and extensive rail connections, as noted in Juhász et al. (2014). This rail infrastructure provides an attractive and more sustainable alternative for European travelers, pointed out by Gaal et al. (2015) on the literature review.

The diversity of respondents' choices illustrates Budapest's popularity global destination, with transportation patterns showing distinct contrasts: in one hand tourist departing from European countries increasingly favor trains, while tourist coming from other continents predominantly rely on airplanes. These findings suggest dual aspects where train travel continues to gain popularity within Europe due to strong rail networks, while international tourism to Budapest still heavily depends on air travel, raising concerns over carbon emissions for those traveling from greater distances. Additionally, Budapest's rail system, by facilitating sustainable transport, could serve as an implementation model for other key cities in different regions and continents.

From the questionnaire answers is also evident that there is awareness among the tourist towards the environmental impact of travel, but the other hand the implementation of tangible actions towards sustainable transportation choices remains limited. A large proportion of respondents 39.2% do not consider their carbon footprint when booking their flight. Additionally, figure 16 shows that 62.2% of respondents have awareness of the carbon footprint, simply knowing about the issue does not lead tourist to act differently or adopt more

sustainable practices. The gap between awareness and action indicates that travelers may recognize the issue but lack either the motivation or resources to incorporate sustainability into their decisions effectively.

The study revealed that air travel was still the highest carbon emitter, particularly for short to medium distances that could be covered by train. Additionally, tourist originating from more distant continents such as Oceania (3832.75 $kgCO_2e$), South America (2417.82 $kgCO_2e$), and North America (1641.57 $kgCO_2e$) produced even higher average GHG emissions per trip than those arriving from Europe (315.07 $kgCO_2e$). The data suggest a high average emission from long distance travelers are responsible for higher emission of CO_2 in the atmosphere, as per discussed previously in the literature review of this thesis. The hypothetical scenario emissions for German and UK travelers indicated that emissions per traveler were highest for car travel, if only 1 person can be found in the certain car, moderate for air travel, and lowest for rail, thus suggesting that rail travel is determined to be the more sustainable means of travelling across Europe. By filling the car with passengers (such as carpooling), the emission can be significantly decreased.

A few suggestions provided involve promoting clear carbon information during the booking process, the availability of public transport and local restaurants to minimize the customers' footprints. Recommendations on how to encourage sustainable choices like using the offset mechanisms highlight the need for systemic ways of promoting green travel.

The outcomes indicate the effectiveness and necessity of promoting railway transport to minimize carbon emissions, provided it is affordable and accessible, especially for younger tourists who prioritize budget-friendly options. The data also underscored that there is, in general, a recognition of sustainability from the tourists, but this recognition does not consistently translate into environmentally conscious travel decisions. This gap could be closed by having clear, relatable carbon information and incentives presented during the process of booking the flight or any other transportation mode.

There were several data limitations in my study, particularly in terms of precise travel route data and reliance with its total distance and the fact that the study was conducted using generalized emissions factors. These constraints could have led to assumptions being made during the analysis, may limit the specificity of carbon footprint insights. Future research using more extensive data on travel could provide further analysis with more detailed breakdowns, and investigate the effects of other demographic and behavioral characteristic factors.

Promoting sustainable tourism in Budapest and the surrounding regions can include providing discounts on rail travel or using environment-friendly service providers. Specifying

the client's carbon footprint might be more persuasive, especially if given in understandable terms for the ordinary person. Future research should look at the impact of such informational interventions and study new developments in transportation impacts on carbon emissions.

In Summary, this research has demonstrates that tourists' transport mode affects carbon emissions and highlights rail travel as a viable sustainable alternative. In this way, I have aimed that through the analysis of the travel behavior and the useful suggestions, this study has offered meaningful insights for both the policy and the practice in order to contribute to the sustainable tourism. With continued collaborative efforts, Budapest has the potential to serve as a model for integrating eco-conscious practices in urban tourism.

If such partnership approaches are maintained and intensified in the future, Budapest has all the possibilities to be presented as a model example of the implementation of the principles of sustainability and ecological responsibility in the city's tourist industry.

SUMMARY

Assessing Sustainable Travel Behavior and Carbon Footprint Climate Impact: a Study of Tourists' Transportation Choices in Budapest Hostels

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BSc in Environmental Engineering
Department of Environmental Analysis and Technologies

Supervisor: Dr. Gérci Gábor
University Associate Professor at Hungarian University of Agriculture and Life Sciences

In this research, I aimed to assess the carbon footprint impacts associated with tourists' transportation choices when traveling to Budapest and to evaluate the potential of reducing these emissions through more sustainable alternatives. By examining emissions produced by various modes of transport, comparing the carbon footprint of air travel versus rail travel, and assessing tourists' awareness of their environmental impact, I focused to identify an effective way to enhance sustainable practices within the tourism industry, helping to ensure that tourism can be both enjoyable and responsible. This study contributes to the expanding collection of research on carbon footprint and sustainable travel, offering insights into how transportation choices specifically affect carbon emissions within the tourism sector. Focused on tourists staying in a hostel in Budapest, the study adopted a questioner to collect the data on their transportation choices, level of awareness on environmental issues and willingness to embrace more sustainable practices. This study concentrated on analyzing air and rail travel as these reflect different levels of carbon footprints. One of the challenges was the availability of precise data collected regarding to the distance traveled by the participants of the questionnaire as emissions changed according to the distance and particular travel routes. The research findings revealed a marked preference for air travel among tourists arriving in Budapest, consistent with trends noted in the literature review, which underscores the increasing demand for aviation. For visitors arriving from outside Europe, air travel remains the most practical and sometimes only realistic option due to the significant distances involved. While trains are considerably more environmentally friendly, their use is limited by geographical and logistical restrictions, particularly for long-distance and intercontinental journeys. This reliance on air travel for long-

haul trips, however, significantly amplifies the carbon footprint, as aviation generates considerably higher CO2 emissions over extended distances than other forms of transport. By highlighting these patterns and preferences, this study emphasizes the need for promoting viable, lower-emission alternatives when possible and increasing awareness among travelers regarding the environmental impact of their travel choices.

ACKNOWLEDGEMENT

I want to express my deepest gratitude to God for the strength and determination He has provided me throughout my life. I am truly thankful for the countless blessings and opportunities that have come my way. I am also deeply grateful for my family's love and support since the moment I decided to move to another continent to pursue my dreams. Their encouragement and life examples have been a vital source of strength and resilience along the way. To my friends, thank you for being my family away from home. Your compassion, encouragement, and endless support have been my joy and strength through every challenge on this journey.

I would like to express my sincere gratitude to my thesis Supervisor Dr. Gábor Géczi and my Co-supervisor: Lóránt Riesz, who was open to listening and embracing my thesis topic and whose guidance, support and patience have helped me to accomplish an additional academic goal in my life. I am honored to have had the opportunity to work with then. Köszönöm szépen!

Additionally, I want to express my gratitude to the Hungarian University of Agriculture and Life Science and the Stipendium Hungaricum Scholarship Program for recognizing my potential and providing me with the financial support that I needed to pursue my studies in this Bachelor program. Lastly, big thanks to my colleagues for the support and the great team vibe throughout the course. Their diverse experiences and knowledge made this journey so much more enriching, as I had the opportunity to learn about their countries and different cultures.

I conclude this chapter with a heart full of gratitude and happiness, cherishing all the blessings that have enriched this journey. Muito obrigada!

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TABLE OF FIGURES

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ANNEX – THESIS QUESTIONNAIRE

Section : Travel Information
1-What kind of transportation did you use?

- Airplane
- Train
- Bus
- Car
- Bicycle
- Other: [Short answer]

2-If you traveled by airplane, did you consider the carbon footprint when booking your flight?

- Yes
- No
- Not applicable

3-What influenced your choice of transportation? (Select all that apply)

- Cost
- Travel time
- Environmental impact
- Comfort
- Availability
- Other: [Short answer]

4-What is your budget for this trip? (in EUR) -Hostel requested

- Less than 100 EUR
- 100-300 EUR
- 301-500 EUR
- 501-700 EUR
- More than 700 EUR

5- How much time are you staying in Budapest? -Hostel requested

- 1-3 days
- 4-7 days
- 8-14 days
- More than 14 days

Section : Accommodation Preferences
6-Do you prefer dormitories or private rooms?

- Dormitories
- Private rooms
- No preference

Section 4: Carbon Footprint Awareness and Behavior
7-How aware are you of the carbon footprint associated with different modes of transportation?

- Very aware
- Somewhat aware
- Not very aware
- Not aware at all

8-How important is it for you to reduce your carbon footprint when choosing a mode of transportation?

- Very important
- Somewhat important
- Neutral

- Not very important
- Not important at all

9-Do you take any steps to reduce your carbon footprint when traveling? (Select all that apply)

- Choosing eco-friendly transportation (e.g., train, bus)
- Offsetting carbon emissions
- Traveling with minimal luggage
- Combining trips to reduce travel frequency
- Other: [Short answer]
- I do not take any steps

10-Have you ever used any methods or programs that compensated for the carbon emissions from your travels?

- Yes
- No
- I'm not sure what this means

11-Would you be interested in learning more about our Eco-Wanderer program, which promotes eco-friendly travel practices?

- Yes
- No
- Maybe

12-On a scale of 1 to 5, how likely are you to choose a more sustainable transportation option if it helps reduce your carbon footprint? (1 being not likely at all, 5 being very likely)

- 1
- 2
- 3
- 4
- 5

Section : Suggestions and Feedback
13-What suggestions do you have for reducing the carbon footprint of travel?
[Short answer]
14-Any additional comments or suggestions regarding sustainable travel?
[Short answer]
Section: Demographic Information
15-Age:

- 18-25
- 26-35
- 36-45
- 46-55
- 56+

16-Gender:

- Male
- Female
- Non-binary
- Prefer not to say

17-Country of Origin:
[Short answer]

ANNEX – DECLARATION OF PUBLIC ACCESS AND AUTHENTICITY

DECLARATION

the public access and authenticity of the thesis

Student's name:	Daiane Fatima Kercher
Student's Neptun code:	T2XGVG
Title of thesis:	**Assessing Sustainable Travel Behavior and Carbon Footprint Climate Impact: a Study of Tourists' Transportation Choices in Budapest Hostels**
Year of publication:	2024
Name of the consultant's institute:	Institute of Environmental Sciences
Name of consultant's deparment:	Department of Environmental Analysis and Technologies

I declare that the final thesis/thesis/dissertation/portfolio submitted by me is an individual, original work of my own intellectual creation. I have clearly indicated the parts of my thesis or dissertation which I have taken from other authors' work and have included them in the bibliography.

If the above statement is untrue, I understand that I will be disqualified from the final examination by the final examination board and that I will have to take the final examination after writing a new thesis.

I do not allow editing of the submitted thesis, but I allow the viewing and printing, which is a PDF document.

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I acknowledge that the electronic version of my thesis will be uploaded to the library repository of the Hungarian University of Agricultural and Life Sciences. I acknowledge that the defended and

- not confidential thesis after the defence
- confidential thesis 5 years after the submission

will be available publicly and can be searched in the repository system of the University.

Date: Budapest, Hungary, 2024/11/05.

Student's signature

ANNEX – CONSULTANT DECLARATION

DECLARATION

Daiane Fatima Kercher, Neptun code: T2XGVG

As a consultant, I declare that I have reviewed the thesis and that I have informed the student of the requirements, legal and ethical rules for the correct handling of literary sources.

I recommend the thesis to be defended in the final examination.

The thesis contains a state or official secret: yes **(x)no**

Date: Budapest, Hungary, 2024/11/05.

_____

Insider consultant