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Comparative analysis of national tourism decarbonisation plans

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Abstract
For tourism to be considered sustainable, the industry needs to be transparent in measuring, monitoring and reporting all emissions to actively contribute to the decarbonisation of the economy. The purpose of this study was to identify to what level tourism decarbonisation has been discussed, assessed, and planned for globally. For this study, a content analysis of national tourism plans was implemented to identify if the carbon footprint of tourism has been assessed, establish a unified approach to measure tourism emissions and determine what level of tourism decarbonisation strategies are currently in place. The findings in this study identified that the carbon footprint of tourism has not been assessed globally, lacks serious discussion and planning for tourism decarbonisation. Crucially, baseline data for tourism emissions are not available, as a result, tourism policymakers cannot monitor and manage the level of decarbonisation in tourism. Furthermore, a unified approach to measure tourism emissions needs to be agreed upon to ensure that each country measures the same criteria. Consequently, allowing policymakers to compare international tourism emissions and establish if tourism is actively transitioning towards a low-carbon industry. Climate change is a significant crisis facing humanity, and until now, this research has not been completed.

Keywords: Climate Change; Greenhouse Gases; Decarbonisation; National Tourism Plans; Carbon Footprint; Analytical Approaches

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Introduction

Climate change is one of the greatest environmental, social, and economic threats facing humankind (EEA, 2019). Tourism is highly sensitive to climate change, and research studies on this theme are critical to continue raising awareness on the need to mitigate climate change (Estevão & Costa, 2020). Furthermore, there is an increase in awareness of the importance of assessing the carbon footprint of tourism to mitigate climate change.

This study aimed to identify if the carbon footprint of tourism has already been established at national level and to determine what level of tourism decarbonisation strategies are in place. This information will enable governments to make informed decisions and generate appropriate plans to reduce tourism emissions. Furthermore, governments will be able to compare tourism emissions internationally and easily monitor tourisms transition towards a low-carbon industry (Patterson & McDonald, 2004; Beckan & Patterson, 2006; Perch-Niesen, Petrus, & Stucki, 2010; Dwyer *et al.*, 2010; Hoque *et al.*, 2010; Konan & Chan, 2010; Farreny, Lamers, Amelung & Oliver-Solà, 2011; Filimonau, Dickinson, Robbins & Reddy, 2013; Sun, 2014; Cadarso, Gómez, López, Tobarra & Zafrilla, 2015; Sanyé-Mengual, Romanos, Oliver & Molina, 2014; Björnsson, 2014; Sharp, Heinonen & Grundius, 2016; Rico, Martínez-Blanco, Montlleó & Rodríguez, 2019). Moreover, there are many analytical approaches used to measure the carbon footprint of tourism. For example, the bottom-up approach assesses the micro-systems, while the top-down approach assesses the macro-systems. Often, these approaches are combined to create a hybrid approach that accounts for the full scope of greenhouse gas emissions (Patterson & Mc Donald, 2004; Beckan & Patterson, 2006; Hoque *et al.*, 2010; Perch-Niesen *et al.* 2010; Dwyer *et al.*, 2010; Filimonau *et al.*, 2013; Sharp *et al.*, 2016). This paper used an integrative comparative analysis to capture the variations in the different methodological approaches utilised in previous international studies.

Limited knowledge is a rationale for research to improve understanding and produce evidence-based decision-making (Scott, 2021a). Therefore, the rationale of this study is based on collecting data to inform the development of a tourism decarbonisation toolkit for destination managers. This study will contribute new knowledge on what level the carbon footprint of tourism has been assessed nationally. Consequently, identifying if a unified approach for measuring the carbon footprint of tourism has been established and applied globally. Additionally, this study will determine what level of tourism decarbonisation strategies are currently in place worldwide to combat climate change.

Most human activities require the combustion of fossil fuels or the removal of carbon sinks (i.e., forests or peatlands). This leads to increased anthropogenic greenhouse gas emissions, causing global warming and severe impacts on the climate system. For instance, extreme weather events occur more frequently (droughts, storms, floods, and heatwaves), melting ice and sea-level rise, risks for human health, socio-economic costs, and risks for ecosystems (Dwyer *et al.*, 2010; Sharp *et al.*, 2016; Riedy, 2016). Climate change and tourism have adverse effects on each other, hence, tourism is expected to reduce emissions drastically by 2050, like all other industries. Lenzen *et al.* (2018) estimated that tourism was responsible for 8% of the overall global emissions with an annual carbon footprint of 4.5 $GtCO_2eq$ in 2013, and it is estimated to reach 6.5 $GtCO_2eq$ by 2025. Globally, tourism is thriving, with 1.5 billion international tourist arrivals in 2019 (a 4% increase from 2018), and this growth is expected to continue. As a result, UNWTO (2020) urges that tourism growth needs to be monitored and managed sustainably.

The structure of this paper firstly highlights the relationship between climate change and tourism. It discusses in detail the analytical approaches that have been used internationally to measure the carbon footprint of tourism at both the national and regional levels. The methodology that was utilised to conduct this research and generate findings is then outlined. Furthermore, this study discusses if a baseline carbon footprint figure can be generated for tourism at a national level. It also assesses if a unified analytical approach to measure tourism emissions at a national level has been applied internationally. This is discussed in light of the current theory in the context of decarbonisation strategies in national tourism plans. Thus, providing background data on the performance of tourism decarbonisation to date.

Literature Review

Climate change and tourism

With decades of tourism growth, millions of tourists have been transported worldwide, producing billions of tonnes of carbon dioxide each year. We now see global COVID-19 tourism recovery plans recognising the need to conserve the planet and tourism's role in mitigating climate change. The OPSTP (2020) vision for a responsible recovery of the tourism sector highlights the central role climate action will now play in all tourism plans internationally. Therefore, COVID-19 has offered tourism an opportunity to recover sustainably.

Climate change and tourism have a bi-directional relationship. Tourism has grown tremendously for decades and is a major global economic industry. However, tourism is a significant contributor to climate change, impacting the industry as it is highly climate-sensitive. Climate and a clean environment are key factors that drive tourism, subsequently, climate change has the potential to alter the popularity of tourism destinations (Mishev & Mochurova, 2010; Hoogendoorn & Fitchett, 2016; Dogru, Marchio, Bulut, & Suess, 2019). The state of the natural environment, perceptions of personal security, and capacity to meet travel costs are other vital resources that influence tourism (Scott, Hall, & Gössling, 2019). Additionally, Hoogendoorn & Fitchett (2016) argue that destinations increasingly threatened by climate change are becoming unsuitable for tourism. Therefore, destinations vulnerable to climate change will suffer adverse economic, social, and environmental impacts.

Climate change affects tourism destinations differently, and some of the most vulnerable are winter, beach and coastal destinations. For instance, winter tourism is threatened by reductions in snowfall and shorter seasons. Beach tourism is pressured by unbearably high temperatures, increased precipitation, changes in wave dynamics, and sea-level rise. Coastal tourism is in danger of extinction due to sea-level rise, which creates implications for local social and economic well-being (Hoogendoorn & Fitchett, 2016; Scott, 2021a). Furthermore, the warming climate in northern Europe is likely to benefit the destinations, making outdoor activities more appealing. In contrast, hot and arid African countries are likely to be negatively affected by the warming climate (Hoogendoorn & Fitchett, 2016; Dogru *et al*., 2019). In 2017, climate change caused 335 natural disasters worldwide, 9,697 deaths, affected the lives and well-being of 95.6 million people and cost US$ 335 billion in total (Estevão & Costa, 2020). Therefore, it is necessary to conduct in-depth and location-specific research on the relationship between tourism and climate change. Thus, this research will support creating appropriate and realistic climate change mitigation and adaptation strategies for tourism.

It is now critical for tourism stakeholders to increase engagement in climate change research. Between 2000-2009, climate change papers represented only 1.7% of all papers published in the leading tourism journals. For the tourism industry to respond effectively to climate change, the scale of research activity must increase drastically (Scott, 2021a; Scott, 2021b). Thus, closing the knowledge gaps in mitigation and adaption strategy. Moreover, the experts who have previously highlighted the importance of understanding the role of tourism in reducing emissions to mitigate climate change have continuously been ignored (Dwyer *et al*., 2010; Sharp *et al*., 2016; Rico *et al*., 2019). As a result, global analysis and policymakers continue to exclude the tourism industry from emission reduction plans. Consequently, tourism plans continue to ignore the importance of measuring the carbon footprint of tourism to monitor sustainability.

In terms of destination planning and development, it has long been recognised that tourism needs to embrace sustainability. However, destinations continue to develop exposed locations and invest in carbon-intensive technologies and market segments (Loehr & Becken, 2021). Scott *et al.* (2019) state that Africa, the Middle East, South Asia, the Caribbean and Indian and Pacific Oceans are tourism hotspots highly vulnerable to climate change impacts. In comparison, Western and northern Europe, central Asia, Canada, and New Zealand are tourism hotspots that are the least susceptible to climate change impacts (Scott, 2021b). In 2019, international tourist arrivals reached 1.5 billion (+4% from 2018). However, tourism demand was slower than in 2017 and 2018, with a 6% increase, mainly in Europe. The Middle East had the most growth in international arrivals (+8%), followed by Asia and the Pacific (+5%), Europe and Africa (both +4%) and the United States of America (+2%) (UNWTO, 2020). Thus, the Middle East and Asia showed the highest increase of international tourist arrivals and are highly vulnerable to climate change. Hence, to maintain this steady growth, the level of vulnerability to climate change needs to be minimised to preserve the desired climate, natural environment, personal security, and travel costs. Therefore, for tourism to mitigate and adapt to climate change, there is a need for improved communications and knowledge mobilisation.

Climate change is one of the most significant challenges for tourism policymakers at all levels nationally, regionally, and internationally (Farid *et al.*, 2016). Global leaders confirmed that there is sufficient information on climate and carbon risks to inform policy and action. However, this does not seem to be transparent in tourism policy and planning. According to Gössling & Scott (2018) and Scott (2021), tourism policymakers and planners appear to be disconnected from the available scientific literature. Additionally, Scott (2021b) proclaims that OECD countries' national tourism climate change policies are inadequate to combat climate change. Moreover, national tourism plans are scarce and/ lack climate change content and strategy (Scott, 2021a; Scott, 2021b). Consequently, leaving the industry vulnerable to accusations of greenwashing sustainability, as tourism committed itself to become climate-neutral by 2050. However, there remains no strategy on how to achieve the necessary emission reductions needed.

Globally, there is a need to increase the level of national tourism plans (Scott, 2021b). There is also a need for policymakers to incorporate tourism strategies into National Adaptation Plans and/ Nationally Determined Contributions, particularly in highly vulnerable countries (Dwyer *et al.*, 2010; Sharp *et al.*, 2016; Rico *et al.*, 2019). Hence, increasing the level of transparency in international tourism climate change mitigation and adaptation strategies. However, as tourism is characterised by strong global interconnectedness, the climate change strategies in one destination can cause implications for another (Hoogendoorn & Fitchett). Hence, it is not a case of one solution fits all; it is evident that there is an urgent need for global collaboration. Tourism academics, industries, and governments need to collectively measure and report the impact of tourism at the national level to determine appropriate and destination-specific mitigation and adaption climate change strategies (Scott, 2021a; Scott, 2021b). As a result, reducing emissions from tourism and avoiding accusations of greenwashing will require action at multiple government levels.

The main climate change challenge faced by tourism is the transition to a low-carbon industry. In other words, the challenge of tourism decarbonisation is to achieve the ambitious emission reduction targets by 2050 (Scott, 2021b; Loehr & Becken, 2021). The total global annual greenhouse gases reached a record high of 53.5 GtCO2eq (+0.7 GtCO2eq from 2016) in 2017. China, the United States of America, and

Europe continue to be the top emitters globally. By 2030, global emissions need to decrease by approximately 25-55% to limit global warming to below 2°C and keep it at 1.5°C (Olhoff, 2018). Globally, the highest emitting sectors are electricity and heat production (25%), agriculture, forestry, and other land use (24%), industry (21%), transportation (14%) and others (16%). Industry emissions involve fossil fuels burned on-site at energy facilities and chemical, metallurgical, and mineral transformation processes which are not associated with energy consumption and waste management activities (EPA, 2019). Under the European Union, Member States are obligated to reduce emissions by 20% in 2020 and 30% by 2030. In addition, Lenzen *et al*. (2018) identified that tourism's global carbon footprint was 4.5 GtCO2eq (2009-2013), accounting for nearly 8% of global greenhouse gas emissions. Transport, shopping, and food are significant contributors to tourism emissions. Thus, tourism is an integrated multisectoral industry with a substantial role in reducing emissions to meet global targets. Therefore, tourism must have high levels of collaboration and communication between all sectors involved.

In 2015, the Paris Climate Agreement was drafted and signed by countries committed to collaborating on climate change mitigation and adaptation. Governments developed policies and strategies to align with 2030 emission reduction goals, and there were specific targets set for international aviation. Since 1997, aviation emissions have been excluded from assessments and reduction policies due to the lack of agreement on the calculation and allocation of emissions (Higham, Ellis & Maclaurin, 2018). Global demand for air travel has grown by 60% over the last ten years, and it is estimated that aviation represents between 1.7% - 2.3% of global carbon emissions. These emissions continue to rise due to the introduction of low-cost airlines, higher incomes, higher levels of education, population growth and urbanisation (Becken & Shuker, 2019; Gössling *et al.*, 2019). If the current growth continues, with no efforts to decarbonise the aviation sector, aviation emissions are predicted to reach levels between 15%-40% of global emissions by 2050 (Baumeister & Onkila, 2018). Moreover, Higham *et al*. (2018) state that the aviation sector has not contributed significantly to mitigating climate change. Airlines still pay no fuel tax, are VAT-exempt, face no legally-binding fuel efficiency requirements, and have no limits placed on their emissions.

As of recent, the public began pressuring the aviation sector to reduce emissions. However, the debate over allocating the responsibility of aviation emissions between air travellers, governments, airlines, or aircraft manufacturers continues (Higham *et al*., 2018). For years, air travellers and policymakers have been convinced that sustainable aviation can be achieved through future technology, alternative fuels, and operational innovations. Nevertheless, this has been described as a myth that stalls implementing climate policies for aviation (Higham *et al*., 2018; Baumeister & Onkila, 2018; Gössling *et al*., 2019). Additionally, governments have continuously encouraged voluntary public behavioural change towards lower-carbon lifestyles, however, this has been ineffective to date. Instead, structural change and public behavioural change are needed to reduce emissions and mitigate climate change (Higham *et al*., 2018; Gössling *et al*., 2019). Therefore, only collective action from multiple institutions can achieve tourism decarbonisation. For instance, policymakers and tourism planners must develop appropriate decarbonisation strategies. Society needs to be prepared to change its travel behaviour, and tourism stakeholders must be willing to transition towards a lower-carbon industry.

Tourism cannot be considered sustainable unless it can be decarbonised (Scott, 2021b). Tourism destinations that are advocating sustainability but provide no evidence of decarbonisation are vulnerable to the accusations of greenwashing (Scott, 2021a). The lack of systematic measuring and reporting capabilities in tourism remains a crucial barrier to identifying the progress being made towards becoming a low-carbon industry. Furthermore, assessing the carbon footprint of tourism is essential to recognise high-intensive emission sources (Sharp *et al*., 2016; Rico *et al*., 2019). The tourism carbon footprint data can be utilised as a guide for developing suitable and location-specific decarbonisation strategies to increase sustainability. Additionally, the data empowers the state government to compare tourism's carbon footprint against other international destinations and other industries. Hence, once the carbon footprint of tourism is identified and understood, only then can appropriate decarbonisation strategies be implemented.

Carbon footprint

The term "carbon footprint" has increased in public appearance and is used regularly to debate emission reduction action against climate change (Wiedmann & Minx, 2008). The carbon footprint is an accounting assessment tool that determines how greenhouse gas-intensive the production and consumption of goods and services are. It allows areas of high emissions to be identified, managed, and eliminated or reduced (Dwyer *et al*., 2010; Rico *et al*., 2019). The carbon footprint offers a comprehensive and understandable method to measure emissions by putting a weighted number on the environmental impact that human activities cause. Activity data from each source of emissions is collected and converted into emission levels. Tourism carbon footprints can be assessed at many levels, other than regional, national, and global. For instance, an individual product, service, tourist, tour operator and sector (Dwyer *et al*., 2010). There are two units of measurement for the carbon footprint assessment, firstly carbon alone (CO_2) and secondly, the six most malicious greenhouse gases known as carbon equivalent (CO_2eq) (Björnsson, 2014). The carbon footprint definition from Carbon Trust (2017) cited in Wiedmann and Minx (2008, p3) refer to carbon footprint as

> '*A carbon footprint is the total greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organisation, event or product, and is expressed as a carbon dioxide equivalent (CO_2e). A carbon footprint accounts for all six Kyoto GHG emissions…*'

Wiedmann and Minx (2008, p4) generated their own definition of carbon footprint

> '*A measure of the exclusive total amount of CO_2 emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product'.*
>
> (Wiedmann and Minx, 2008, p4)

However, Wiedmann and Minx (2008, p4) do not include all the greenhouse gases in their definition. Nevertheless, both definitions suggest that the direct and indirect emissions caused by human activity need to be measured for accuracy. Notwithstanding, the definition that includes all greenhouse gases will be utilised throughout this study to ensure the full scope of emissions is measured. Furthermore, this definition avoids underestimating the carbon footprint.

Carbon footprint measurements

Tourism produces direct and indirect emissions through its purchases of goods and services. Direct emissions are generated directly from tourist activities. By only assessing carbon, the level of accuracy is minimised as indirect emissions are excluded. Indirect emissions can be much higher due to other emission causing activities related to the industry (Dwyer *et al*., 2010). For example, fuel combustion generates direct emissions. However, indirect emissions are generated from heating, air-conditioning, lighting, cooking, and growing food products in hotels (Sun, 2014; Cadarso, Gómez, López & Tobarra, 2016). It is recommended to assess direct and indirect emissions in the unit measurement of carbon equivalent (Sharp *et al*., 2016). Carbon is estimated to have a 100-years life expectancy in the atmosphere, and carbon equivalent is calculated with the same expectancy (Björnsson, 2014). Therefore, to maintain a standardised measurement, direct and indirect emissions must be assessed in the form of carbon equivalent. A standardised approach ensures that international tourism carbon footprints are easily compared and monitored.

Analytical approaches that measure the carbon footprint of tourism
Within the literature, there are three analytical approaches used to assess the carbon footprint of tourism: carbon calculators and toolkit approaches, comprehensive approaches (bottom-up approach and/ life cycle analysis or the top-down approach and/ the environmental input-output approaches) and hybrid approaches (combination of the comprehensive approaches). Each approach and toolkit differ in the type of tourism consumption that they measure in the carbon footprint assessments. In addition to this, the approaches and toolkits have many different advantages, limitations, and barriers (Table 1-3).

Carbon calculators and toolkit approaches
Carbon calculators and toolkits are available online for users to input their data or download for free. For example, the European Tourism Indicator System toolkit, Environmental Protection Agencies recommended carbon calculators, CARMACAL, and DEFRA Greenhouse Gas conversion factors. The European Tourism Indicator System toolkit was created to encourage destinations to adopt a more sustainable approach to tourism planning. This toolkit helps destinations manage and monitor sustainable tourism (EU, 2016). Users download the pre-developed surveys, destination profiles and datasheets, and formulas to facilitate measuring sustainability. However, the main limitation of this toolkit is that it only focuses on direct aviation and transport carbon emissions. Thus, excluding the full scope of tourism emissions. This toolkit was previously attempted in Ireland to assess the carbon footprint of tourists in the regions of Clare, Sligo, and Donegal (Hanrahan *et al*., 2018). However, to overcome the limitations of this toolkit, the Environmental Protection Agencies recommended '*Carbon Calculator*' was utilised instead (Table 5).

EPA (2020) recommends three-carbon calculators that can be used by individuals, businesses, institutions, and local authorities. However, Filimonau (2011) argues that carbon calculators are inaccurate as they do not targ*et al*l tourism components at once and cannot be generalised globally. Nevertheless, the calculators are user-friendly as they highlight areas of high emissions and offer advice on how to reduce or offset emissions. The '*WWF calculator'* was used to measure the carbon footprint of German tourists to specific destinations (Grimm *et al*., 2008). This calculator is portrayed as an online survey; it only assesses direct emissions and has many limitations. For example, the questions are very generic, and it measures emissions that are not related to tourism, such as utility bills. These questions are unavoidable and must be answered to move on. Therefore, this calculator was excluded from Table 1-3 due to the high levels of limitations. The '*Carbon Calculator'* is more comprehensive as it measures the direct and indirect emissions. Also, this calculator uses the data from DEFRA greenhouse gas conversion factors, and it is ISO 9001:2015 certified. According to the International Organisation for Standardisation (2018) and Naden (2018), ISO 9001:2015 data provides globally agreed principles, requirements, and guidelines for quantifying and reporting the carbon footprint of a product.

DEFRA greenhouse gas conversion factors have independent standards for carbon footprint accounting and reporting. Initially, it was designed for businesses in the United Kingdom, however, the scope of application has dramatically extended to several other European countries, Australia and New Zealand (Filimonaua *et al*., 2011; Filimonaua *et al*., 2013). This approach is suitable for destination marketing organisations, environmental agencies, policymakers, and hotel/ tourism associations. The main barrier to implementing this approach is that it has not been designed to assess the carbon footprint of tourism in developing countries.

The '*CARMACAL*' calculator measures direct and indirect emissions, and it won an award for its level of innovation. This calculator is business orientated for tour operators, travel agencies, or entire destinations (Hardemann, 2018; Travel life, 2020). However, this calculator can have high financial costs as it requires interdisciplinary collaborations and excludes food and beverages' carbon footprint. Hence, this calculator underestimates the carbon footprint of tourism.

Bottom-up approach and life-cycle analysis
The bottom-up approach is consistent with the consumption-based view of greenhouse gas accounting and is based on process analysis. Tourist behaviour is the centre of this approach. Furthermore, it focuses on micro-systems, details from the energy system and insights into technology development. However, it is very data-heavy, time-consuming and requires more resources, but it is incredibly accurate. This approach was applied in Antarctica and Iceland (Table 4) (Becken & Patterson, 2006; Vuuren, Hoogwijk, Barker & Riahi, 2009; Farreny *et al.*, 2011; Lin, Liu, Meng, Cui, & Xu, 2013; Björnsson, 2014; Sun, 2014). Nevertheless, these studies were limited to direct emissions and did not analyse the full impact of tourism emissions. Therefore, it is recommended to combine this approach with the life-cycle analysis as they share similar qualities.

Previous researchers claim that the life-cycle analysis is a more comprehensive approach compared to the bottom-up approach. The life-cycle analysis evaluates the direct and indirect emissions based on the environmental damages from the production, use, and disposal stages of a product or service. The life-cycle analysis can estimate the carbon footprint of a person, industry, organisation, community, or an entire nation (Franchetti & Apul, 2013). The city of Barcelona assessed the direct and indirect emissions from tourism with this approach and used the ISO 14040:2006 data (Rico *et al.*, 2019). As a result, when measuring tourism emissions, the level of accuracy is enhanced by combining both the bottom-up approach with the life-cycle analysis.

Top-down approach and input-output analysis
The top-down approach is built on the input-output analysis, focusing on a broad economic context of the entire economy. This approach requires knowledge of specialised matrix calculations using monetary data (Vuuren *et al.*, 2009). For example, the '*Tourism Satellite Accounts*' is a statistical tool that keeps track of the demand for goods and services linked to tourism. It manages the economic data against environmental accounts, thus, measuring the direct and indirect emissions (Dwyer *et al.*, 2010; Björnsson, 2014; Sun, 2014). This approach is internationally recommended as it is less time consuming and superior for the macro-systems. For example, the industrial sectors, individual businesses, larger product groups, and governments.

Even though this approach is internationally recommended, there are many limitations and barriers to implementing this approach. For instance, it lacks the ability to monitor minor changes as it does not gather enough detailed information. Furthermore, it neglects the use and end-of-life phases in the life-cycle of products or services. Also, there are issues of incompleteness, truncation errors and that it is based on historical behavioural evidence (Vuuren *et al.*, 2009; Lin *et al.*, 2013). For example, Cadarso *et al.* (2015) implemented this approach and used historical tourism data from 2007 to measure the carbon footprint of tourism in Spain. By utilising tourists' historical behaviour rather than actual behaviour, this approach does not portray tourisms' present-day environmental impact. Since the tourism industry has continuously grown throughout the years and tourists are travelling further and more frequently, this approach is potentially underestimating tourism emissions. Furthermore, Perch-Niesen *et al.* (2010) found this approach to be inaccurate in Switzerland compared to the bottom-up approach.

Nevertheless, Hawaii and Spain utilised this approach due to the lack of available data (Konan & Chan, 2010; Cadarso *et al*., 2015). If a destination is listed on the Tourism Satellite Accounts, this approach is practical, however, only 70 countries are listed on these accounts. Consequently, creating barriers to implementing this approach globally.

Hybrid approach

There are two known types of hybrid approaches. The first hybrid is known as the environmentally extended or economic input-output life-cycle analysis. This approach is considered the best, as it combines the data and strengths from the bottom-up and top-down approaches (Lin *et al*., 2013; Sun, 2014). Therefore, reducing the weaknesses and uncertainty from each approach. For instance, the accuracy of calculations is improved by replacing economic data with physical data; to solve price heterogeneity. This approach is especially beneficial for the aviation and accommodation sectors as it measures actual flight miles and room nights instead of the monetary units (Becken & Patterson, 2009; Sharp, Grundius & Heinonem, 2016; Sun, Cadarso & Driml, 2020). This approach was implemented in Iceland, Switzerland, Australia, New Zealand, and Japan (Patterson & McDonald, 2004; Becken & Patterson, 2006; Dwyer *et al*., 2010; Hoque *et al*., 2010; Perch-Niesen *et al*., 2010; Sharp *et al*., 2016; Kitamura *et al*., 2020). Thus, a hybrid approach includes tourists' actual behaviours (distance travelled, nights stayed) in the input-output framework. Additionally, Table 4-5 shows that this approach is the most dominant choice amongst international studies.

The second hybrid approach implemented in the Algarve in Portugal is the DEFRA - life-cycle analysis. It measures the direct emissions from energy use, fuel combustion, and fuel chain-related indirect emissions (Filimonau *et al*., 2013). Consequently, it utilises the benefits from the life-cycle analysis to measure the indirect emissions from the energy-generating and transport-related infrastructure and capital goods.

From comparing the international studies (Table 4), it is evident that a consistent and unified approach is needed for tourism (Sun, 2014). The data from these studies are not directly comparable because there are limited similarities: the analytical approaches used, the scope of impact measure, the timeframe of measurement and units of measurement differ in each study. Thus, yielding an inconsistent basis for comparison.

The literature highlights the critical importance of measuring and reporting tourism emissions at a national level to actively decarbonise the industry. Furthermore, the literature gives valuable insight and understanding of the advantages, limitations and barriers of the different analytical approaches and toolkits used to assess the carbon footprint of tourism. Globally, there needs to be an increase in interdisciplinary collaboration within the tourism industry to generate credible tourism emissions data. Consequently, gathering this data will reduce the barriers to implementing a unified approach to measure tourism emissions. Thus, tourism policymakers and planners can develop evidence-based and destination-specific decarbonisation strategies and compare tourism emissions internationally.

Research Methodology

According to UNWTO (2019), transforming tourism for climate action requires embracing a low-carbon pathway. Awareness of tourism emissions and the optimisation of decarbonisation strategies are crucial elements. Hence, the impetus for this study was to determine what level of tourism decarbonisation strategies are in place worldwide.

Table 1. *Comparing the analytical approaches and toolkits used to measure the carbon footprint of tourism*

Criteria Assessed	Approaches and toolkits							
	European Tourism Indicator System	Carbon Calculator (EPA)	DEFRA GHG Conversion Factors	CARMACAL	Bottom-up/ Life Cycle Analysis (LCA)	Top-down/ Environmentally Extended Input-Output Analysis (EE IO)	EE IO LCA (Hybrid)	DEFRA-LCA (Hybrid)
Type of tourism consumption measured								
Aviation and transportation	X			X				
Accommodation				X				
Building energy use, food and beverages, and offsetting programs								
Tourism activities				X				
Assess emissions of all products and services consumed (by one) on a journey		X	X		X		X	X
All products and delivery chain emissions traced through the economic-environmental accounts						X	X	
Expenditure on tourism products and services								
Life-cycle analysis (emissions from production to end-of-life)		X			X		X	X
Barriers for implementing approaches and toolkits								
Lack of data, awareness, and familiarity with the toolkit	X	X	X	X	X	X	X	X
Lack of resources					X	X	X	
Requires interdisciplinary collaboration	X			X		X	X	
Doubts on credibility	X	X	X	X	X	X	X	X
Financial pressure		X		X	X		X	X
Time-consuming	X		X		X		X	X
Challenges for macro-level data analyses, uncertainty and estimation errors increase when consumers preferences are heterogeneous					X			
Complex and unmanageable with large visitor volumes and a lack of transparency as restricted public access to the background data		X			X			
Not designed for developing countries		X	X					X
Various styles of the approach make comparisons difficult – no single standard						X		
Tourism Satellites Accounts are not available in every country						X	X	

Note: X indicates that this variable assessed is present

Sources adapted and modified: (Becken & Patterson, 2009; Filimonaua *et al*, 2011; Filimonau *et al*, 2013; Juvan & Dolnicar, 2014; Björnsson, 2014; Sun, 2014; Cadarso *et al*, 2015; EC, 2016; Sharp, Grundius and Heinonem, 2016; Tudorache *et al*, 2017; Sun, Cadarso & Driml; 2020; Sun & Drakeman, 2020 Travel life, 2020; Carbon Footprint Ltd; 2021)

Table 2. *Comparing the analytical approaches and toolkits used to measure the carbon footprint of tourism*

Criteria Assessed	**European Tourism Indicator System**	**Carbon Calculator (EPA)**	**DEFRA GHG Conversion Factors**	**CARMACAL**	**Bottom-up/ Life Cycle Analysis (LCA)**	**Top-down/ Environmentally Extended Input-Output Analysis (EE IO)**	**EE IO LCA (Hybrid)**	**DEFRA-LCA (Hybrid)**
Advantages of approaches and toolkits								
Identifies and prioritises sustainability issues, flags the need to increase the availability of sustainability options and suggests actions	X							
Free for individuals and micro-businesses only and compares your carbon footprint with the average person in your country		X						
Flexible system that can be adapted to the needs of destinations and easy to compare results internationally	X							
Free access, user friendly, can be adjusted and 'ready to employ'	X		X					
There are videos on how to work the calculator on their website				X				
Estimates emissions associated with supply chain and differentiates types of diets		X						
Includes emissions from distance uplift/ radiative forcing		X				X	X	
Differentiates between international and domestic tourists and identifies tourists travelling together	X	X	X	X	X	X	X	X
EPA recommended, and it considers emissions by the type of flight (domestic, short/ long haul), seat class and average occupancy		X						
Regularly updates data	X	X	X	X	X		X	X
Advises on reducing carbon footprints		X		X				
Won an award and can enter specific itinerary details per day, and it will save data				X				
Gives a breakdown of total carbon emissions into categories	X	X	X	X	X			X
Linked to google maps- easily finds the distance between any two places				X				
Potentially a much greater accuracy			X		X		X	X
Quantifies the linkages between tourism contribution to the economy and its impact on emissions						X		
Data is already collected, and it identifies consumption patterns					X	X	X	X
Pinpoints emission hot spots and predicts changes if alternatives are chosen					X			
Enables a national tourism carbon inventory to be comprehensive and compatible with the System of National Accounts						X		
Can be implemented at single-region or multi-region			X			X	X	X
Integrates sustainability into macro-level policy framework and disseminates information on tourism, carbon emissions and social welfare						X	X	
Comparable nationally, as based on the Tourism Satellite Accounts						X	X	
Measures the sectoral-level emissions within the Paris Agreement while linking it with the progress of Sustainable Development Goals						X	X	
Internationally recognised tool – used by GHG Protocol			X					

Criteria Assessed	Approaches and toolkits							
	European Tourism Indicator System	Carbon Calculator (EPA)	DEFRA GHG Conversion Factors	CARMACAL	Bottom-up/ Life Cycle Analysis (LCA)	Top-down/ Environmentally Extended Input-Output Analysis (EE IO)	EE IO LCA (Hybrid)	DEFRA-LCA (Hybrid)
Contains detailed background information which explains the development of specific emission values		X	X					X
Improves the accuracy by replacing monetary data with physical, to solve price heterogeneity, reduces estimation errors and includes tourists' actual behaviours							X	
More accurate and comprehensive							X	X
Reduces levels of uncertainty							X	
Increases effective target campaigns					X			
Most holistic method, capable of estimating the direct and the maximum extent of indirect GHG emissions from products and services								X

Note: X indicates that this variable assessed is present
Sources adapted and modified: (Becken & Patterson, 2009; Filimonaua *et al*, 2011; Filimonau *et al*, 2013; Juvan & Dolnicar, 2014; Björnsson, 2014; Sun, 2014; Cadarso *et al*, 2015; EC, 2016; Sharp, Grundius and Heinonem, 2016; Tudorache *et al*, 2017; Sun, Cadarso & Driml; 2020; Sun & Drakeman, 2020 Travel life, 2020; Carbon Footprint Ltd; 2021)

A content analysis was the primary quantitative analysis tool utilised within this study. According to Hannam and Knox (2015), tourism researchers increasingly use content analysis to critically investigate textual forms of data, for example, written documents such as tourism plans. Content analysis is a scientific tool and the only research methodology used to determine textual meaning (Krippendorff, 2004). The content analysis draws conclusions from certain premises and samples through an inductive, deductive, or abductive process (Gheyle & Jacobs, 2017). This analysis can have a quantitative or qualitative approach. It is not pre-defined, therefore, it requires the construction of categories whilst reading through the texts and then these findings are coded (Krippendorff, 2004; Gheyle & Jacobs, 2017). Thus, conducting a quantitative content analysis of major national tourism plans worldwide determines the current state of play concerning tourism decarbonisation.

Method

The Paris Agreement is a legally binding international treaty on climate change that 196 Parties adopted in 2015, with intentions of limiting global warming to well below 2°C. For countries to achieve this, they aim to be a climate-neutral world by the mid-century (UNFCCC, 2021). This study determines the level of national tourism decarbonisation strategies in place worldwide to achieve climate-neutrality. In order to identify and analyse government published data that explicitly relates to national tourism plans, the authors conducted an external desk-based research method by using the google search engine. The authors cross-examined the google searches of each country's national tourism plans. For instance, the plans that were in the native language of each country were translated. Consequently, ensuring that worldwide national tourism plans were identified and that no relevant data were excluded. Additionally, the authors investigated the governmental website of each country.

Table 3. *Comparing the analytical approaches and toolkits used to measure the carbon footprint of tourism*

Criteria Assessed	Approaches and toolkits							
	European Tourism Indicator System	Carbon Calculator (EPA)	DEFRA GHG Conversion Factors	CARMACAL	Bottom-up/ Life Cycle Analysis (LCA)	Top-down/ Environmentally Extended Input-Output Analysis (EE IO)	EE IO LCA (Hybrid)	DEFRA-LCA (Hybrid)
Limitations of approaches and toolkits								
Underestimates the carbon footprint	X	X		X				
Overestimates the carbon footprint						X		
Not explicitly made for tourism, time-consuming and accurate data required		X						
Emission inventories are not regularly updated					X			
Not suitable for individual use	X		X	X	X	X	X	X
LCA in the building sector is not rational, and variations in itineraries and purchasing patterns make it difficult to accurately complete the carbon footprint analysis					X			
If system boundaries are not thoroughly described, there is a risk of under-estimation	X				X	X	X	X
Inaccurate assumptions of maximum load factors and average occupancies from certain modes of transportation					X		X	X
Homogeneity: assumes that all businesses produce using the same standard of technology/ proportionally: implies that the impact will be doubled if consumption of one service is doubled. Does not consider price fluctuations or capacity utilisation ratios						X		
Limited to key impact categories due to data required and the workload	X	X		X		X		
Not able to breakdown energy consumption at business levels and reduces effective targeting of energy efficiency campaigns						X		
Applications of this method in other countries should be made with caution			X					X
Does not consider potential end-use GHGs or land-use change impacts	X						X	
Incomplete sectorial statistics and assumed linear relationships between sector outputs and environmental burdens						X	X	
Unable to address the totality of the life cycle emissions and other indirect emissions from the non-fuel chain-related capital goods and infrastructure	X		X					
Some uncertainty as assumptions must be made for products and services. Precise calculations and final results are difficult to truly establish		X		X	X	X	X	

Note: X indicates that this variable assessed is present

Sources adapted and modified: (Becken & Patterson, 2009; Filimonaua *et al*, 2011; Filimonau *et al*, 2013; Juvan & Dolnicar, 2014; Björnsson, 2014; Sun, 2014; Cadarso *et al*, 2015; EC, 2016; Sharp, Grundius and Heinonem, 2016; Tudorache *et al*, 2017; Sun, Cadarso & Driml; 2020; Sun & Drakeman, 2020 Travel life, 2020; Carbon Footprint Ltd; 2021)

Table 4. *Comparison of international studies that have assessed the carbon footprint of tourism at a national level*

Sourced Articles	Destination	Analysis Approach	Scope of Impact	Year Data Extracted	Unit of Measurement	Total Carbon Footprint	Average Tourist Carbon Footprint
Carbon Footprint of Tourism at a National Level							
Grimm *et al.* (2008)	**Mexico**	WWF carbon calculator	Direct	2007	CO_2	7.218 kg CO_2/ per trip (14 days, 2 people)	515.6 Kg CO_2/ per tourist per day
Björnsson (2014)	**Iceland**	Bottom-up/ LCA	Direct	2011 (Summer only)	CO_2	-	50.2 kg CO_2/ per day
Sharp *et al.* (2016)	**Iceland**	Hybrid	Direct & indirect	2010-15 (2013 for average tourist)	CO_2eq	6.4 Million tons CO_2eq	1350 kg CO_2eq
Perch-Niesen *et al.* (2010)	**Switzerland**	Hybrid	Direct	1998	CO_2eq	2.29 Million tons CO_2eq	-
Dwyer *et al.* (2010)	**Australia**	Hybrid	Direct, indirect & imports	2003-04	CO_2eq	54.4 Mt CO_2eq	-
Sun (2014)	**Taiwan**	Top-down/ Input–output	Direct, indirect & imports	2007	CO_2eq	15 Mt CO_2eq	-
Cadarso *et al.* (2015)	**Spain**	Top-down/ Input–output	Direct & indirect & imports	2007	CO_2	63129 kt CO_2	-
Farreny *et al.* (2011)	**Antarctica**	Bottom-up	Direct	2008-09	CO_2	198,843 Tons CO_2	490 Kg CO_2/ per tourist
Patterson & McDonald (2004)	**New Zealand**	Hybrid	Direct & indirect	1997-98	CO_2	6.8 Mt CO_2	-
Becken & Patterson (2006)	**New Zealand**	Hybrid	Direct	1997-98	CO_2	2689 Kt CO_2	-
Kitamura *et al.* (2020)	**Japan**	Hybrid	Direct & indirect	2017	CO_2eq	136 Mt CO_2eq	-
Carbon Footprint of Tourism at Regional Level							
Grimm *et al.* (2008)	**Trentino, North Italy**	WWF Carbon calculator	Direct	2007	CO_2	216 kg CO_2/ per trip (5 days, 2 people)	43.4 Kg CO_2/ per tourist per day
Grimm *et al.* (2008)	**Majorca, Spain**	WWF Carbon calculator	Direct	2007	CO_2	1.2221 kg CO_2/ per trip (14 days, 3 people)	87.2 Kg CO_2/ per tourist per day
Sanyé-Mengual *et al.* (2014)	**Menorca, Spain**	Bottom-up/ LCA	Direct	2010-2011 (Summers only)	CO_2	277 kg of CO_2 per stay (20 days	14.6 Kg CO_2/ per tourist per day
Rico *et al.* (2019)	**Barcelona, Spain**	Bottom-up/ LCA	Direct & indirect	2015	CO_2eq	9.6 Mt CO_2eq	96.93 Kg CO_2eq/ per tourist per day

Carbon Footprint of Tourism at a National Level							
Sourced Articles	**Destination**	**Analysis Approach**	**Scope of Impact**	**Year Data Extracted**	**Unit of Measurement**	**Total Carbon Footprint**	**Average Tourist Carbon Footprint**
Hoque *et al.* (2010)	**Queensland, Australia**	Hybrid	Direct & indirect	2003-04	CO_2eq	12.01-13.86 Mt CO_2eq	-
Filimonau *et al* (2013)	**Algarve, Portugal**	Hybrid	Direct & indirect	-	CO_2eq	-	627.5 Kg CO_2eq/ per tourist per day
Konan & Chan (2010)	**Hawaii, USA**	Top-down & input-output	Direct & indirect	1997 & 2005	CO_2eq	5.2 Mt CO_2eq	-
Hanrahan *et al.* (2018)	**Clare, Ireland**	Carbon calculator	Direct	2017 (Summer)	CO_2eq	-	218- 333 kg CO_2/ per tourist
Hanrahan *et al.* (2018)	**Sligo, Ireland**	Carbon calculator	Direct	2017 (Summer)	CO_2eq	-	218- 333 kg CO_2/ per tourist
Hanrahan *et al.* (2018)	**Donegal, Ireland**	Carbon calculator	Direct	2017 (Summer)	CO_2eq	-	118 -229 kg CO_2/ per tourist per trip

Sources adapted and modified: (Patterson & McDonald, 2004; Becken & Patterson, 2006; Grimm *et al.*, 2008; Dwyer *et al.*, 2010; Hoque *et al.*, 2010; Konan & Chan, 2010; Perch-Niesen *et al.*, 2010; Farreny *et al.*, 2011; Filimonau *et al.*, 2013; Sanyé-Mengual *et al.*, 2014; Björnsson, 2014; Sun, 2014; Cadarso *et al.*, 2015; Sharp *et al.*, 2016; Hanrahan *et al.*, 2018; Rico *et al.*, 2019; Kitamura *et al.*, 2020).

Table 5. *Summary of criteria to determine the level of discussion, assessment, and planning for decarbonisation of tourism*

- Is there sustainable tourism development? (i.e., education and training, investment and encouragement, marketing)
- Is there education on the relationship between tourism and climate change?
- Do the plans mention emissions?
- Are there emission reduction plans and targets set?
- Do they engage with leading international institutes advice/ criteria? (i.e., ETIS, GSTC, UN SDG, EPA)
- Is there education on carbon footprint? (i.e., what it is, reduction targets, international standards on how to measure and report it)
- Have they measured and reported tourism emissions?
- What analytical approach have they used to measure tourism emissions?
- Are there any carbon initiatives in place?
- Is decarbonisation mentioned and explained?
- Are they offsetting emissions or educating on how to offset?
- Are they sequestering carbon via carbon sinks/ stocks? (i.e., ocean, peatland, forestry)
- Is there a carbon management program? (i.e., to measure, reduce and offset emissions annually)
- Do they mention implementing labels/ certificates (i.e., carbon standards and/ environmental standards)?
- Is there a low-carbon sector/ economy development?
- Is there a carbon-neutrality/ climate-neutral development?
- Is there a carbon negative/ zero/ net-zero development?
- Are they aiming to transform the economy/ destination? (i.e., circular/ sharing/ green/ blue)

Source adapted and modified: (Sun, 2014; EC,2016; UN, 2020; Intrepid, 2020; GSTC, 2021; UNFCCC, 2021)

The criteria (18) used to analyse these plans were developed from an in-depth theoretical analysis on decarbonisation and climate change. A theoretical framework was constructed to facilitate the content analysis of these plans from this analysis. Within this theoretical framework, the principle guiding documents worldwide from the Sustainable Development Goals (UN, 2020), GSTC Destination Criteria (GSTC, 2021) and the European Tourism Indicators System (EC,2016) can be seen as illustrated in Table 5. According to Patil (2020), the quantitative content analysis approach explores the trends, vision, behaviour, and future course of action in communication material. One of its significant advantages is that it reduces the respondent's bias.

This study utilised this approach to identify the criteria (18) in the national tourism plans, as a result, they provide a framework for constant comparison. In order to secure a valid sample, the authors carefully considered the sampling and selection procedures for this study.

Sample and Selection

Given that this study aimed to identify to what level tourism decarbonisation has been discussed, assessed, and planned for worldwide. The research involved a total population of 208 countries (World Population Review, 2020), national tourism plans.

Data Analysis

The data generated from each national tourism plan were inputted into a content analysis tool for constant comparison throughout the research process. Thus, it highlights any similarities or differences between the plans. Additionally, the authors included the quantitative data of the total carbon footprint of the entire economy for each country. However, please note there is nothing available for the tourism carbon footprint, as there is a lack of quantitative indicators on tourism across all countries. This data analysis procedure allowed the authors to use the content analysis tool (Table 5) to identify to what level of tourism decarbonisation has been discussed, assessed, and planned for worldwide. The authors translated the extracted eighteen criteria into the native language of each country to avoid the exclusion of national tourism plans. As a result, certifying that the extracted data of national tourism plans are thorough and that no relevant data were excluded.

Results and Discussion

The principal areas that emerged from within the analysis are discussed in the context of global, national tourism plans. The content analysis approach aims to identify to what level the carbon footprint of tourism has been discussed, assessed, and planned for decarbonisation worldwide. Initial findings from the content analysis of 208 countries identified that 59% had a national tourism plan, as illustrated in Appendices 1-6. Of the 59%, 95% of the national tourism plans focused on sustainable tourism development. However, only 42% of the national tourism plans discuss the relationship between tourism and climate change. Together, the present findings confirm that national tourism plans are scarce and/ lack climate change content and strategy (Scott, 2021b). Climate action is one of the main goals for sustainable development (UN, 2020). Hence, climate change content and strategies must be integrated into national tourism plans to minimise the knowledge gaps worldwide. A crucial finding is that 83% of the plans did not discuss carbon emissions or their intentions to reduce tourism emissions. According to Gössling & Scott (2018) and Scott (2021b), global leaders confirmed that there is adequate information on climate change and carbon risks to inform policymakers. From these results, it is clear that national tourism plans are not providing transparent and adequate information to inform the decarbonisation of tourism.

The analysis also identified that 67% of the plans do not express their engagement with international institutions guidelines, such as UN Sustainable Development Goals, GSTC, ETIS and EPA. This result highlights that tourism policymakers and planners are disconnected from the world tourism leader's sustainable tourism guidelines and criteria (Gössling & Scott, 2018; Scott, 2021b). Consequently, this analysis shows an urgent need for global collaboration amongst tourism academics, the industry itself, and governments to collectively measure and report the impact of tourism at a national level to combat climate change.

The main climate change challenge faced by tourism is the transition towards a low-carbon economy. This transition includes the decarbonisation of tourism to achieve the emission reduction targets (Scott, 2021b; Loehr & Becken, 2021). The analysis determined that 88% of the national tourism plans do not provide education and information on measuring the carbon footprint of tourism. Cyprus was the only country that showed evidence of measuring and reporting the carbon footprint of tourism in their national tourism plan. In addition, they highlighted that they utilised the bottom-up approach to measure the carbon footprint of tourism.

Moreover, 98% did not discuss the decarbonisation of tourism. These results demonstrate that tourism policymakers and planners are ignoring the importance of measuring and reporting the carbon footprint of tourism, as suggested by Sun (2014), Sharp *et al.* (2016) and Rico *et al.* (2019). Thus, knowledge gaps are being created, making it difficult to establish appropriate tourism decarbonisation plans and strategies. Hence, tourism's ability to transition towards a low-carbon industry is being jeopardised. According to Scott (2021b), tourism cannot be considered sustainable unless it can be decarbonised. Therefore, 99% of the national tourism plans and strategies are vulnerable to criticism as they claim to be striving for sustainable tourism. Thus far, globally, tourism policymakers and planners have not yet measured and reported the carbon footprint of tourism.

Additionally, the content analysis recognised that 95% of the national tourism plans did not discuss decarbonisation strategies such as offsetting emissions. Sequestering carbon and carbon management programs were both only mentioned in 2% of the national tourism plans. Furthermore, decarbonisation or environmentally friendly labels and/ certifications were considered in 21% of the national tourism plans. According to Gössling & Buckley (2016), carbon labels are currently ineffective because of the deficiencies in communications. Together, these findings suggest a serious lack of discussion and planning around tourism decarbonisation strategies. This finding is worrying as the industry has ambitious reduction targets to meet. Nevertheless, national tourism plans are not disclosing a baseline tourism carbon footprint and are not educating tourism stakeholders on specific tourism decarbonisation strategies. Consequently, national tourism plans are not encouraging the decarbonisation of tourism. In addition, there is a severe lack of discussion and strategies in place to transition tourism towards a low-carbon industry, with only 11% of the national tourism plans mentioning this.

Developing tourism as a carbon-neutral or carbon-negative industry was discussed even less within the national tourism plans. However, 24% of the national tourism plans discussed transforming the tourism destination and the economy towards a circular, sharing, green or blue economy and destination. Hence, Scott (2021b) suggested that national tourism plans and strategies are inadequate to face the challenges of climate change is demonstrated within this study. There is a serious lack of documented evidence for tourism decarbonisation planning at global, EU and national levels. If global, EU, and national tourism plans are not measuring, monitoring and reporting transparent baseline figures for tourism emissions and associated decarbonisation strategies, then the following questions are raised:

how serious are we about sustainable tourism? As tourism academics, practitioners and planners, what role do we have in highlighting this to ensure the long-term sustainability of the tourism sector?

These findings identified that the carbon footprint of tourism lacks serious discussion and has not been assessed at a national level globally. Therefore, policymakers lack the appropriate and necessary knowledge to implement realistic tourism decarbonisation strategies to combat climate change. Furthermore, there is a significant lack of collaboration between academics, the tourism industry, and governments. Multiple tourism carbon footprint assessments have been conducted in the academic field (Table 4), yet there is no reference to these findings in the national tourism plans. Likewise, there is evidence that the Philippines Statistics Authority has assessed the carbon footprint of tourism in the Philippines (UNWTO Academy, 2021). The methodology that the Philippines study utilised was the Tourism Satellite Accounts and the environmental and economic accounts. Nevertheless, this was also not referenced within the Philippines national tourism plan. Consequently, Olhoff (2018) suggested theory to decrease emissions by approximately 25-55% to limit global warming to below 2°C by 2030 is not being supported. It will be challenging to achieve this reduction unless critical action occurs. For instance, the carbon footprint of tourism at a national level needs to be assessed worldwide, and drastic decarbonisation planning needs to be implemented immediately.

Conclusion

Contribution

This paper has discussed both an international and national perspective on the relationship between tourism and climate change. This study has intended to contribute new knowledge and enhance the understanding of the importance of measuring and reporting tourism's carbon footprint in order to decarbonise the tourism industry and mitigate climate change. As tourism is a significant contributor to climate change, Scott (2021b) has highlighted that decarbonising tourism is crucial for mitigating climate change. In addition, Sun (2014) has emphasised the importance of assessing the carbon footprint of tourism with a unified approach. This analysis identified that tourism policymakers and planners need this information to ensure that resources are allocated efficiently, that appropriate and destination-specific decarbonisation strategies are implemented, and to easily monitor tourism's transition towards a low-carbon industry.

Many national tourism agencies continue to state that they strive to deliver sustainable tourism, in this regard, Ireland is no exception. For example, Fáilte Ireland (2017) stated

> *'as an organisation focused exclusively on the sustainable development of Irish tourism, Fáilte Ireland must ensure that its goals, strategies and programmes are at all times aligned to the emerging needs of the sector'* (Fáilte Ireland, 2017, p.5)

However, this analysis highlights that little is measured, monitored and reported concerning the carbon footprint of tourism. With the majority of national tourism plans (99%) collectively creating a significant knowledge gap regarding each country's tourism carbon footprint and tourism decarbonisation strategies. This study identified that within all the global tourism plans, Cyprus is the only country that has provided consistent indicators. Cyprus has assessed the carbon footprint of tourism and reported the measurement in the national tourism plan. Additionally, Cyprus has provided information on the methodological approach used to measure tourism emissions. That being said, countries such as France need to be commended for their recent tourism climate and environmental measures. This study identified that France lacked consistent indicators across their national tourism plan, however, Murray (2021) states that the French National Assembly has voted to suspend domestic airline flights on routes that can be travelled by direct trains, with the aim of reducing emissions. In conclusion, the carbon footprint of tourism has not yet been assessed globally, lacks serious discussion and planning. Policymakers and tourism planners cannot monitor the level of decarbonisation in tourism if they do not measure and report tourism emissions. Nevertheless, Cyprus and France are providing hope and encouragement for other countries to take necessary climate action to decarbonise tourism.

Implications and Limitations

This study established the need for a unified carbon footprint analytical approach, scope of impact, timeframe of measurement, and unit of measurement. The data from international studies was incomparable and caused implications of forming a baseline carbon footprint measurement for tourism. Nevertheless, the hybrid approach measured in the form of carbon equivalent is considered the most optimal approach to assess the carbon footprint of tourism. It accounts for both direct and indirect tourism emissions. Likewise, it maintains a standardised measurement to compare and monitor international tourism carbon footprints easily. However, there are barriers to implementing the hybrid approach to measure the carbon footprint of tourism internationally, as the Tourism Satellite Accounts are not available globally. Hence, the bottom-up and life-cycle analysis approach should be utilised until the Tourism Satellite Accounts are available worldwide. In addition, implications arose from completing the content analysis of national tourism plans, as 28% needed to be translated. However, with the help of technology, these were translated, allowing the national tourism plans to be transparent and compared internationally.

Future research directions

This paper is part of a more comprehensive doctoral research project, thus, facilitating further research. This research will allow for a much larger study of assessing the carbon footprint of tourism for specific destinations. This assessment identified that the carbon footprint of tourism has not been assessed at a national level. Furthermore, the national tourism plans and strategies lack serious discussion on tourism decarbonisation. Hence, future research could focus on identifying a practical decarbonisation toolkit for the tourism industry in order to reduce emissions effectively, which can be adapted for specific destinations. For example, a country like New Zealand may be affected more by the carbon footprint of long-haul travel distances than countries like Italy or Spain, which may have more short-haul visitors. However, there needs to be a global alliance that the carbon footprint of tourism should be measured and reported annually. Additionally, a unified approach needs to be agreed upon, as advocated by Sun (2014). As well, a standard scope of impact needs to be determined to ensure that each country measures the same criteria. Consequently, a unified approach and a standard scope of impacts will give tourism policymakers and planners the ability to compare international tourism carbon footprints and establish if tourism is making the necessary emission reductions to combat climate change.

Appendix 1. *Content analysis of national tourism plans*

Destination	Total CF of the economy Mt/ MMT CO2 eq	Criteria: Sustainable/ sustainability	Climate change	CO2/ emissions	Greenhouse gases reduction	Engage with leading international institutes	CF	CF of tourism measurement	CF Analytical Approach used	Carbon Initiatives	Decarbonise	Offset emissions	Carbon sequestration (sinks/ stocks)	Carbon management	Labels/ certificates	Low-carbon sector/ economy development	Carbon-neutrality/ climate-neutral	Carbon negative	Transforming economy/ destination
Europe																			
Albania (2018)	-	X				X													
Austria (2019)	79 Mt CO2 eq (2018)	X	X	X	X	X									X		X		
Belgium (Brussels) (2020)	118.5 Mt CO2 eq (2018)	X				X									X				X
*Bosnia & Herzegovina (2008)	-	X				X									X				
*Bulgaria (2014)	57.8 Mt CO2 eq (2018)	X																	
Croatia (2013)	23.8 Mt CO2 eq (2018)	X													X	X			
Cyprus (2017)	8.8 Mt CO2 eq (2018)	X	X	X	X	X	X	X	X			X	X		X	X	X	X	X
*Czechia (2019)	128.1 Mt CO2 eq (2018)	X																	
*Estonia (2013)	20 Mt CO2 eq (2018)	X																	
France (2005)	444.8 Mt CO2 eq (2018)	X			X	X	X								X				
Germany (2017)	858.4 Mt CO2 eq (2018)	X	X	X	X	X										X			X
Greece (2016)	92.2 Mt CO2 eq (2018)	X	X			X										X			
Hungary (2017)	63.2 Mt CO2 eq (2018)	X	X																X
Ireland (2019)	60.9 Mt CO2 eq (2018)	X																	X
Isle of Man (2016)	-	X																	

		Criteria																	
Destination	**Total CF of the economy Mt/ MMT CO_2 eq**	Sustainable/ sustainability	Climate change	CO_2/ emissions	Greenhouse gases reduction	Engage with leading international institutes	CF	CF of tourism measurement	CF Analytical Approach used	Carbon Initiatives	Decarbonise	Offset emissions	Carbon sequestration (sinks/ stocks)	Carbon management	Labels/ certificates	Low-carbon sector/ economy development	Carbon-neutrality/ climate-neutral	Carbon negative	Transforming economy/ destination
*Italy (2017)	427.5 Mt CO_2 eq (2018)	**X**		**X**															**X**
Jersey (2018)	-	**X**																	**X**
Kosovo (2017)	-	**X**																	
*Latvia (2019)	11.7 Mt CO_2 eq (2018)	**T**																	**T**
Lithuania (2003)	20.3 Mt CO_2 eq (2018)	**X**																	
Malta (2015)	2.2 Mt CO_2 eq (2018)	**X**													**X**				
*Moldova (2014)	-	**X**																	
Montenegro (2008)	-	**X**	**X**			**X**													
Netherlands (2019)	188.2 Mt CO_2 eq (2018)	**X**		**X**	**X**		**X**												**X**
*North Macedonia (2018)	-	**X**																	
Poland (2015)	412.9 Mt CO_2 eq (2018)	**X**	**X**													**X**			**X**
*Portugal (2017)	67.4 Mt CO_2 eq (2018)	**X**				**X**													

*Note: CF= Carbon footprint; *= translated plan; X= Key variable/s present in plan; PD = Plan detected but no mention of key variables; */PD= Translated and plan detected but no mention of key variables*

Appendix 2. *Content analysis of national tourism plans*

Destination	Total CF of the economy Mt CO_2 eq (Million tonnes) MMT CO_2eq (Million Metric Tons)	Criteria: Sustainable/ sustainability	Climate change	CO_2/ emissions	Greenhouse gases reduction	Engage with leading international institutes	CF	CF of tourism measurement	CF analytical approach used	Carbon Initiatives	Decarbonise	Offset emissions	Carbon sequestration (sinks/ stocks)	Carbon management	Labels/ certificates	Low-carbon development	Carbon-neutrality/ climate-neutral	Carbon negative	Transforming economy/ destination
Europe																			
*Romania (2018)	116.1 Mt CO_2 eq (2018)	**X**	**X**		**X**		**X**									**X**			**X**
Russia (2019)	-	***/PD**																	
*San Marino (n.d.)	-	**X**																	
Serbia (2016)	-	**X**	**X**	**X**	**X**	**X**													**X**
*Slovakia (2013)	43.3 Mt CO_2 eq (2018)	**X**				**X**													
Slovenia (2017)	17.5 Mt CO_2 eq (2018)	**X**	**X**			**X**													
*Spain (2019)	334.3 Mt CO_2 eq (2018)	X	X			X													X
*Svalbard (2015)	-	**X**			**X**										**X**				
Switzerland (2017)	-	X	X			X													X
*Ukraine (2017)	-	***/PD**																	
Nordic Countries: Iceland, Sweden, Norway, Denmark, Finland, Faroe Islands, Åland Islands, Greenland	Mt CO_2eq Iceland: 4.9 (2018) Sweden: 51.8 (2018) Denmark: 48.2 (2018) Finland: 56.4 (2018)	**X**	**X**			**X**											**X**		
England (2011)	462.1 Mt CO_2 eq (2018)	**X**																	
Scotland (2020)		**X**	**X**	**X**	**X**													**X**	
Wales (2020)		**X**		**X**	**X**						**X**	**X**				**X**			
North America, Central America, and the Caribbean																			
Anguilla (2011)	-	**X**	**X**	**X**											**X**				**X**

		Criteria																	
Destination	**Total CF of the economy Mt CO_2 eq (Million tonnes) MMT CO_2eq (Million Metric Tons)**	Sustainable/ sustainability	Climate change	CO_2/ emissions	Greenhouse gases reduction	Engage with leading international institutes	CF	CF of tourism measurement	CF analytical approach used	Carbon Initiatives	Decarbonise	Offset emissions	Carbon sequestration (sinks/ stocks)	Carbon management	Labels/ certificates	Low-carbon development	Carbon-neutrality/ climate-neutral	Carbon negative	Transforming economy/ destination
Aruba (2020)	-	**X**																	
Barbados (2014)	-	**X**	**X**			**X**	**X**												**X**
Belize (2011)	-	**X**	**X**	**X**											**X**				
Bermuda (2018)	-	**X**					**X**												
Bonaire (2017)	-	**X**	**X**							**X**									**X**
Canada (2019)	728 Mt CO_2 eq (2018)	**X**																	**X**
Cayman Islands (2019)	-	**X**	**X**		**X**	**X**						**X**			**X**	**X**			

*Note: CF= Carbon footprint; *= Translated plan; X= Key variable/s present in plan; PD = Plan detected but no mention of key variables; */PD= Translated and plan detected but no mention of key variables*

Appendix 3. *Content analysis of national tourism plans*

Destination	Total CF of the economy Mt CO_2 eq (Million tonnes) MMT CO_2eq (Million Metric Tons)	Criteria: Sustainable/ sustainability	Climate change	CO_2/ emissions	Greenhouse gases reduction	Engage with leading international institutes	CF	CF of tourism measurement	CF Analytical Approach used	Carbon Initiatives	Decarbonise	Offset emissions	Carbon sequestration (sinks/ stocks)	Carbon management	Labels/ certificates	Low-carbon s development	Carbon-neutrality/ climate-neutral	Carbon negative	Transforming economy/ destination
North America, Central America, and the Caribbean																			
*Costa Rica (2017)	-	X	X			X	X								X				X
Curaçao (2015)	-	X																	
Dominica (2013)	-	X		X			X											X	
*El Salvador (2008)	-	X																	
*Guatemala (2015)	-	X	X		X		X												
Hawaii (2020)	19.58 MMT CO_2eq (2016)	X	X			X													X
*Honduras (n.d)	-	X		X															
Jamaica (2015)	-	X	X			X									X				
Montserrat (2016)	-	X																	
*Panama (2008)	-	X		X											X				
Saint Lucia	-	X				X													
Trinidad and Tobago (2010)	-	X	X	X	X		X					X			X				
United States of America (2012)	6677 MMT CO_2eq (2018)	PD																	
South America																			
*Bolivia (2015)	-	X																	
*Brazil (2018)	-	X	X	X	X	X						X							
*Chile (2015)	-	X																	
*Colombia (2018)	-	X	X																
*Ecuador (2019)	-	X	X																
Falkland Islands (2015)	-	X																	X
Guyana (2019)	-	X				X					X					X			X
*Peru (2016)	-	X	X	X	X	X	X						X		X	X			X
*Uruguay (2019)	-	X	X																X
Oceania																			
Australia (2019)	535.8 Mt CO_2eq (2018)	X																	X

		Criteria																	
Destination	**Total CF of the economy Mt CO_2 eq (Million tonnes) MMT CO_2eq (Million Metric Tons)**	Sustainable/ sustainability	Climate change	CO_2/ emissions	Greenhouse gases reduction	Engage with leading international institutes	CF	CF of tourism measurement	CF Analytical Approach used	Carbon Initiatives	Decarbonise	Offset emissions	Carbon sequestration (sinks/ stocks)	Carbon management	Labels/ certificates	Low-carbon s development	Carbon-neutrality/ climate-neutral	Carbon negative	Transforming economy/ destination
Federated States of Micronesia (2015)	-	**X**	**X**			**X**													
Fiji (2019)	-	**X**	**X**		**X**	**X**													
Kiribati (2009)	-	**X**	**X**																

*Note: CF= Carbon footprint *= Translated plan; X= Key variable/s present in plan; PD = Plan detected but no mention of key variables; */PD= Translated and plan detected but no mention of key variables*

Appendix 4. *Content analysis of national tourism plans*

		Criteria																	
Destination	**Total CF of the economy Mt CO_2 eq (Million tonnes) MMT CO_2eq (Million Metric Tons)**	Sustainable/ sustainability	Climate change	CO_2/ emissions	Greenhouse gases reduction	Engage with leading international institutes	CF	CF of tourism measurement	CF Analytical Approach used	Carbon Initiatives	Decarbonise	Offset emissions	Carbon sequestration (sinks/ stocks)	Carbon management	Labels/ certificates	Low-carbon s development	Carbon-neutrality/ climate-neutral	Carbon negative	Transforming economy/ destination
Oceania																			
New Zealand (2019)	78.9 Mt CO_2eq (2018)	X	X	X												X	X		
Palau (2016)	-	X	X		X														
Papua New Guinea (2006)	-	X	X																
Samoa (2014)	-	X	X			X													
Solomon Islands (2015)	-	X	X																
Africa																			
*Benin (2013)	-	X	X												X				
*Burkina Faso (2018)	-	X				X													
*Burundi (2011)	-	X	X																
*Republic of the Congo (2016)	-	X																	X
Eritrea (1999)	-	X																	
Ethiopia (2015)	-	X	X	X											X				
Ghana (2012)	-	X				X									X				
Kenya (2017)	-		X												X				
Lesotho (2019)	-	X	X		X	X	X												
Liberia (2015)	-	X	X			X									X				
Malawi (2019)	15.1 Mt CO_2eq (2017)	X	X			X													
Morocco (2013)	-	X																	X
Mozambique (2014)	-	X	X																
Namibia(2008)	-	X																	
Nigeria (2006)	-	X																	
Rwanda (2009)	-	X				X													
*São Tomé and Príncipe (2018)	-	X	X																
Seychelles (2018)	-	X	X		X	X								X	X				X
South Africa (2016/17)	-	X		X			X			X									
Tanzania (2015)	-	X																	
Uganda (2014)	-	X																	
IGAD region																			

		Criteria																	
Destination	**Total CF of the economy Mt CO_2 eq (Million tonnes) MMT CO_2eq (Million Metric Tons)**	Sustainable/ sustainability	Climate change	CO_2/ emissions	Greenhouse gases reduction	Engage with leading international institutes	CF	CF of tourism measurement	CF Analytical Approach used	Carbon Initiatives	Decarbonise	Offset emissions	Carbon sequestration (sinks/ stocks)	Carbon management	Labels/ certificates	Low-carbon s development	Carbon-neutrality/ climate-neutral	Carbon negative	Transforming economy/ destination
Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan, Uganda (2013)	-	**X**		**X**									**X**		**X**				
								Asia											
Azerbaijan (2016)	-	**X**																	

*Note: CF= Carbon footprint *= Translated plan; X= Key variable/s present in plan; PD = Plan detected but no mention of key variables; */PD= Translated and plan detected but no mention of key variables*

Appendix 5. *Content analysis of national tourism plans*

Destination	Total CF of the economy Mt CO2 eq (Million tonnes) MMT CO2eq (Million Metric Tons)	Criteria: Sustainable/ sustainability	Climate change	CO2/ emissions	Greenhouse gases reduction	Engage with leading international institutes	CF	CF of tourism measurement	CF Analytical Approach used	Carbon Initiatives	Decarbonise	Offset emissions	Carbon sequestration (sinks/ stocks)	Carbon management	Labels/ certificates	Low-carbon s development	Carbon-neutrality/ climate-neutral	Carbon negative	Transforming economy/ destination
Asia																			
Bangladesh (2010)	-	X				X													
Bhutan (2019)	. -5.57 Mt CO2eq (2015)	X				X	X									X			X
Brunei (2018)	-	X																	
China (2012)	-	X																	
*East Timor (n.d)	-	X				X													
India (n.d)	-	X																	
Indonesia (2018)	-	X																	
Japan (2016)	1,249.9 Mt CO2eq (2016)	X																	
Malaysia (2016)	-	X													X				
Maldives (2013)	-	X	X		X											X	X		
Myanmar (Burma) (2013)	-	X	X	X	X	X	X					X		X	X	X			
Nepal (2016)	32 Mt Co2eq (2011)	X	X																
Philippines (2016)	128 Mt CO2eq (2017)	X	X																
Qatar (n.d)	-	PD																	
Saudi Arabia (n.d)	-	X																	
Sri Lanka (2017)	-	X				X													
Tajikistan (n.d)	-	X																	
Thailand (2017)	-	X													X				X
Turkey	-	PD																	
Timor	-	X																	

*Note: CF= Carbon footprint *= Translated plan; X= Key variable/s present in plan; PD = Plan detected but no mention of key variables; */PD= Translated and plan detected but no mention of key variables*

Appendix 6. *Countries that no national tourism plan was identified*

Afghanistan	Iran	Saint Kitts and Nevis
Algeria	Iraq	Saint Pierre and Miquelon
Andorra	Israel	Saint Vincent and the Grenadines
Angola	Jordan	Senegal
Antigua and Barbuda	Kazakhstan	Sierra Leone
Argentina	Kuwait	Singapore
Armenia	Kyrgyzstan	Somalia
Bahrain	Laos	South Korea
Belarus	Lebanon	South Sudan
Botswana	Libya	Sudan
Cambodia	Liechtenstein	Suriname
Cameroon	Luxembourg	Syria
Cape Verde	Madagascar	Taiwan
Central African Republic	Mali	The Bahamas
Chad	Marshall Islands	The Gambia
Comoros	Martinique	Togo
Côte d'Ivoire	Mauritania	Tonga
Cuba	Mexico	Tunisia
Democratic Republic of the Congo	Monaco	Turkmenistan
Djibouti	Mongolia	Tuvalu
Dominican Republic	Nauru	United Arab Emirates
Egypt	Nicaragua	Uzbekistan
Equatorial Guinea	Niger	Venezuela
Eswatini (Swaziland)	Northern Ireland	Vietnam
Gabon	North Korea	Yemen
Georgia	Oman	Zambia
Grenada	Pakistan	Zimbabwe
Guinea	Palestine	
Haiti	Paraguay	

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