Analyzing Visitor Viewpoints Toward Carbon Off-Setting Using a Smart Indicator System (SIS)

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Abstract

This paper presents empirical insights into the use of technological strategies to analyze visitor viewpoints toward carbon off-setting regarding six islands along the West Coast of Ireland. A methodological approach was developed which included the following three basic components: well-defined research objectives, digital resources and the appropriate use of QR codes using mobile devices. The research strategy included three variants. These were developed with a view to obtaining data that shed light on visitor's viewpoints regarding carbon off-setting in the pre-trip phase. A survey instrument was used to assist the principal investigators and QR codes were placed on posters encouraging the island visitors to take the survey using their mobile devices. One of the key advantages of this strategy was the high volume of data obtained after the survey was completed. The study identifies the need to educate and promote carbon off-setting in the future.

Keywords: Measure; Monitor; Carbon Off-setting; Tourism; Islands; Ireland; QR codes; Technology-enabled; Hybrid vehicles

Background

The six islands examined in this study are located off the west coast of Ireland from Galway to Donegal, these are the three Aran Islands (Inisheer, Inishmore, Inishmaan), Inishbofin, Tory and Arranmore. The islands attract a broad demographic of tourists due to their unique culture and their position in the Atlantic Ocean (Claddagh Design 2020). Moreover, the measuring and monitoring of tourism is essential for small islands (Rodriguez, Aguilera, Martín and Salinas 2018). Barcoe and Hanrahan (2022) emphasize the need to utilise SMART technology when implementing an evidenced-based approach to sustainable tourism. Nevertheless, there has been little written on these six islands in relation to sustainability, evidenced-based planning, measuring and monitoring the impact of tourism. This gap in knowledge creates an opportunity for this investigation to shed light on the benefits of using evidenced-based planning, indicator systems (ETIS) and SMART technology as a supporting strategy in respect of destination planning for these six islands in the future.

Introduction

The main purpose of this paper is to shed light on the benefits and challenges of using a SMART indicator system when analyzing visitors' viewpoints and behaviors towards carbon off-setting when visiting these six islands. Previous research has not fully explored the implementation of a SMART strategy to measure carbon footprint using indicators. Both academics and practitioners have noted there is a range of new complexities that accompany the use of technology when collecting big data from tourism indicators [1]. As such, there was a need to reconceptualize the research model by using technologies such as QR codes to maximize destination planning on small islands [2]. The findings of this study provide a comparative analysis between the benefits of using a SMART strategy and the stakeholder engagement needed to implement such a destination management strategy in the future.

Although studies on the use of technology to measure and monitor tourism detail the specialized advancements in obtaining data using tourism indicators, extant literature does not provide a framework specific to Irish tourism and its structure [3]. This deficiency is surprising, as both academics and practitioners acknowledge new complexities that accompany this use of technology, agreeing that research into destination management should be reconceptualized to maximize data collection [2]. When measuring and monitoring the impact of tourism on small islands, technology remains an untested phenomenon. Nevertheless, the

findings of this research provide an advanced understanding of implementing SMART strategies to measure and monitor the impact of tourism on islands using indicators. This study adds to the growing body of destination management literature by utilizing technology for destination management. In sum, the aim is to inform both theory and practice of the ways in which technology could be of practical benefit in the future.

Literature Review

This section begins by clarifying the terminology that will be used throughout this paper. While the literature is growing on QR Codes that were used to obtain the data, some areas remain under-researched (Liao and Lee 2010). The use of QR Codes in destination management, for example, is very much an emerging research topic [4]. Following on from the recommendation of Booth (2008), this section provides a brief introduction to the impact of QR Codes, their history and the development of technology in destination management research. This will be followed by an exploration of the use of these technologies in the collection of data using indicator systems such as the European Indicator Tourism System (ETIS) and the recommendations of the global sustainable tourism council (GSTC) [3]. This section also examines the key fundamentals of combining the use of technology and indicators to measure, monitor and mitigate the impact of tourism on small islands (Kakoudakis & McCabe, 2018).

The Origins of QR Codes, Big Data and How they are Used

The Denso Wave Company, a subsidiary of Toyota, are credited with inventing the QR code (Coleman 2011). QR (quick response) codes are two dimensional images that can be scanned by a tablet or smart phone's camera, prompting the device to open a web page, display an image or for the purpose of this study, display a survey page (Denso Wave 1994). QR codes vary in data-carrying capabilities and there are less error corrections needed on IOS devices (Coleman 2011). Nevertheless, developers have created new varieties of QR codes evolving their application, interpretation and processes, thus a given QR code may not be readable by a given device or delays may be experienced in areas with poor Wi-Fi (Coleman 2011).

At tourism destinations, QR codes can be used in convenient locations such as ferry ports, airports, hotels, bus stops and B&Bs (Hoang Vu 2010). Moreover, the use of this technology can benefit destination managers in the collection of big data regarding visitor's behavior at specific locations to manage the development of tourism (Sigala, Gretzel, Xiang and Koo 2015). The main aim of this process is to create an evidenced-based framework utilizing indicators that will inform best practice regarding tourism planning in the future (Hoang Vu, Đai Nghia, Truong 2018). However, the expansion of this framework will depend on stakeholder engagement (Barcoe and Whelan 2019). The key concept of utilizing this technology is to support the use of indicator systems in destination management (Lou and Tian 2017). Figure 1 illustrates Tourism infrastructure when using technologies such as QR codes for the purposes of destination management. As Liao and Lee (2017) explain, the use of technology can support the expansion of a data collection framework in respect of destination management. This, coupled with the creation of quantitative surveys linked to an indicator system and stakeholder engagement will allow destination managers to inform tourism planning strategies in the future (Hoang Vu, Đai Nghia, Truong 2018, Barcoe and Whelan 2018).
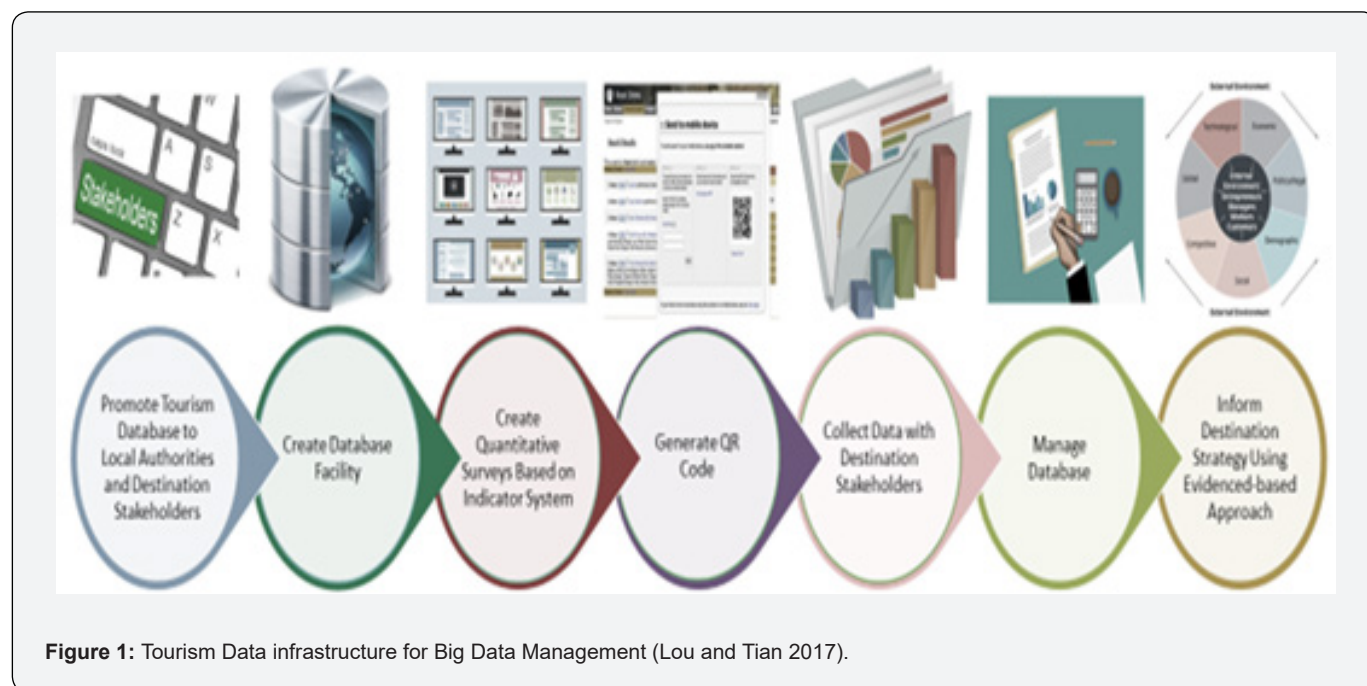

Figure 1: Tourism Data infrastructure for Big Data Management (Lou and Tian 2017).

Tourism Planning in Ireland

Over a period of six years (2013-2019) the Irish tourism industry experienced exponential growth in visitations (Tourism Ireland (TI) [5]). This increase led to major implications for tourism planning. Sustainable planning and its insights have brought about pervasive changes regarding destination management at a local level in Ireland [6]. O'Rourke [7] highlights this point by underlining the positive effect that planning and development has had on the Burren in Co. Clare. This was achieved through the engagement of key stakeholders and via the workable insights obtained from evidence-based planning (Gibson 2016). Sustainable planning in regions such as Burren has developed the insights obtained from indicator systems through a network of partnerships that engages all key stakeholders in relation to the management of the local ecosystem [8]. Through analyzing key economic and social data, planners can interact with their stakeholders and understand the significant processes that are needed to implement an evidenced-based destination management strategy [7]. In view of this rapidly growing trend in Irish tourism, and the actionable insights of evidence-based planning, local authorities have been integrating concepts of sustainable planning in their destination management strategies (Fáilte Ireland (FI) [9]). Considering the expanding role that sustainable planning now contributes to destination management not many authors have investigated the use of indicator systems in relation to Ireland [6]. Despite this widespread adoption of evidence-based planning in Co. Clare, the successful practices of sustainable tourism in an Irish context remain under-researched [10] (Gibson 2016).

The Fundamentals of Measuring and Monitoring Tourism on the Island of Ireland

Cheer (2020) describes small islands as rare citadels for ecological safekeeping and tight-knit communities. The long-term growth in tourism on the island of Ireland has had major implications for its future planning (Barcoe and Hanrahan 2022). Sustainable tourism in Ireland has evolved to a stage where the measuring and monitoring of sustainable indicators to facilitate evidenced informed planning is essential [11]. The implementation is best achieved by combining the ETIS and recommendations from the GSTC (Barcoe and Hanrahan 2022). Mc Loughlin and Hanrahan [12] highlight the absence of sufficient monitoring of several key tourism impacts at destination level. A key consideration in this area is poorly planned tourism that impacts on the future of destination planning (Dredge & Jamal, 2015; Dredge & Jenkins, 2007; Hall & Jenkins, 1995; Liasidou, 2019; Ruhanen, 2010; Shao et al., 2020). Nevertheless, few approaches have provided insight into Local Authorities practices in Ireland in particular, the six islands along the west coast (Barcoe and Hanrahan 2022).

Maguire [12] notes that there are still issues with measuring and monitoring regarding tourism planning in Ireland citing the distribution of funding as a key issue. The task of the local authorities is to create long term objectives, implement strategies and frameworks that will benefit Ireland up to 2025 (FI 2021). Any regional planning or development strategy in Ireland must include guidelines and tools to help policy-makers move toward a more sustainable form of tourism planning (Planning and Development Act 2000 and 2010). As a result, tourism planning in Ireland has become an instrument of regional development (Griffin and Carty 2006). Tourism that uses key metrics can have a positive effect on rural locations in Ireland such as the six islands along the west coast (Maguire 2021). Several studies suggest that local governments play an essential role in bringing economic prosperity to these regions and their communities [11] (Brokaj, 2014; White, 2010; Crofts, 2010).

Most of the research regarding the implementation of evidenced-based planning in Irish tourism examines the forming of partnerships between local authorities and communities [11]. This may enhance the ability of local authorities to measure and monitor tourism more sustainably [13], (Gibson, 2012). This socio-economic approach helps to ensure a sustainable long-term industry (Murphy 1985) [14-17]. It is noteworthy from the viewpoint of local authorities; the depth and level of planning performance may have had significant influence over the development of measuring and monitoring strategies in the Irish tourism sector over the past decade [10]. Figure 2 outlines previous research strategies that have led to the development of evidenced-based tourism in Ireland over the past decade. This model illustrates key research developments in relation to evidenced-based planning in Ireland. Each study highlights the requirements necessary for implementing a system to measure and monitor the impact of tourism in Ireland however, Mc Loughlin and Hanrahan [12] identify a lack of enthusiasm with respect to these practices.

Why Measuring and Monitoring Carbon Off-Setting is so Important in the Context of Island Tourism

Tourism is a very sensitive activity in relation to carbon off-setting due to the impact on local environments (European Environment Agency, 2019; Estevão and Costa, 2020). The key challenge that tourism industry faces is that it must become climate-neutral by 2050 [18]. Bojanic and Warnick (2019) advocate the importance of decarbonization to mitigate climate change. Nevertheless, this is happening at a very slow pace compared to what is necessary for climate neutrality and stability (Dwyer et al., 2010; Sun, 2014; Sharp et al., 2016; European Commission, 2018; Rico et al., 2019; Becken and Higham, 2021). Moreover, the threat to sensitive environments such as the six islands of this study is growing day by day [2]. In analyzing the literature, it became apparent that the tourism industry is routinely excluded from national emission reduction plans globally [19-21] (Estevão and Costa, 2020, European Environment Agency, 2019). The existing research regarding the six islands off the west coast of Ireland

does not comprehensively explore carbon off-setting (Barcoe and Hanrahan 2022) [22]. There were no strategies identified that mitigate the carbon footprint of visitors travelling along the west coast of Ireland. This gap creates the opportunity for this study to break new ground by measuring carbon footprint in the pre-trip phase and analyzing the viewpoints of visitors regarding carbon off-setting in the pre-trip phase [23].
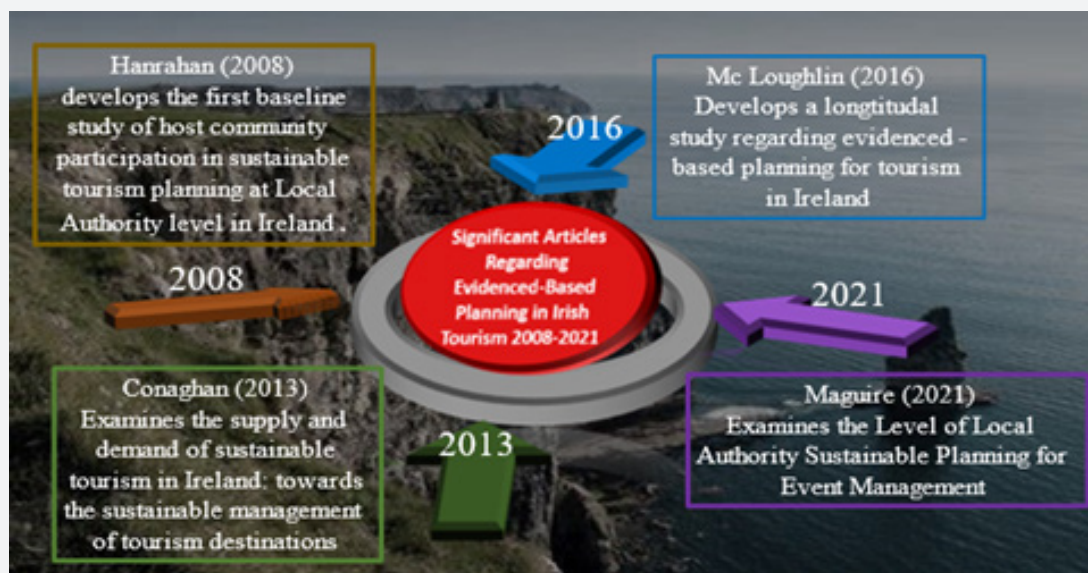

Figure 2: Research Timeline for Evidence-based Planning in Ireland.

Methodology

Based on the aim of the study, a set of three qualitative surveys (visitor, resident and enterprise) were designed using ETIS and GSTC indicators as a template for guidance [24]. Each question was linked to a specific indicator. This paper will focus on the first dataset, the visitor survey. This investigation exposed the lack of data available in respect of the six islands off the west coast of Ireland. Table 1 outlines the islands included in the study, the local authority responsible for the implementation of the tourism strategy, the location and the total area of each island in Km sq [25]. To analyze carbon footprint, a research framework was designed to provide key insights into the effects of visitor behaviors in the Pre-trip phase [26]. This model identifies three key indicators that shed light on the CO_2 footprint of the visitor and why they may not have off-set their CO_2 in the Pre-trip phase [27]. This is reflected in Figure 3 where the concept of the model focuses on four key areas of the data, availability of carbon off-setting, visitor's attitudes toward carbon off-setting, examining the modes of transport used by visitors and measuring the carbon footprint of visitors in two categories (National and international [28]. Prior to the collection of the primary data, the chairperson of each island committee was contacted to create stakeholder engagement. Following the approval of the project, a poster containing a QR code was created and distributed amongst the stakeholders [29].

Table 1: Islands Included in the Study (CSO 2022).

| Name of Island	Local Authority Region	Population	Location	Area Per KM SQ
Inish Méain	Galway County Council	183 (2016 fig.)	40.8km from Galway Mainland	19km sq.
Inisheer	Galway County Council	281 (2016 fig.)	39.5km from Galway Mainland	48km sq.
Inis Mór	Galway County Council	762 (2016 fig.)	46.9km from Galway mainland	31km sq.
Inisbofin	Galway County Council	180 (Approx.)	9.9km from Cleggan Galway	12km sq.
Aranmore	Donegal County Council	489 (Approx.)	5 km/3 miles off the coast of, Donegal	18km sq.
Tory Island	Donegal County Council	100 (Approx)	14.5 km from Donegal	3.52 km sq.
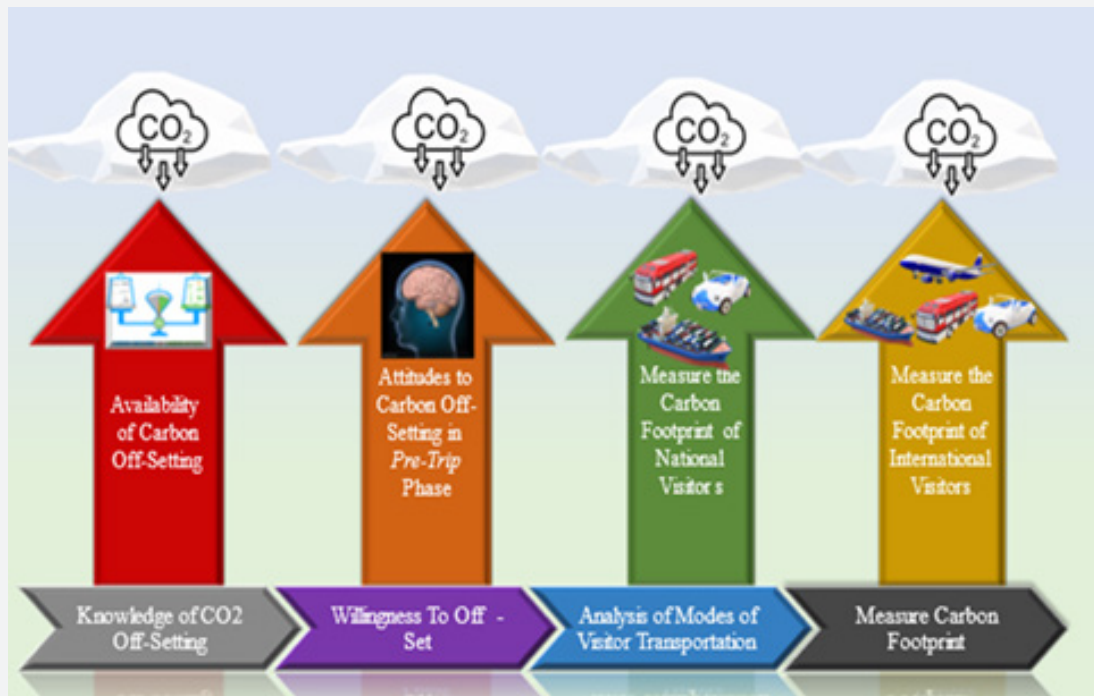
Figure 3: Research Framework for the Study.

The main aim was to obtain key insights that would monitor visitors' viewpoints and habits regarding carbon off-setting when travelling to each island [30]. Figure 4 highlights the use of QR codes in phase one of the strategy. Data collection from visitors began in June 2022 and ended in September 2022 [31]. Type form was the survey instrument used to collect data online and face-to-face on each island. Respondents were asked to scan the QR code and take the survey. Researchers also administered the survey face to face providing mobile devices to the respondents when needed [32]. One significant drawback from using this approach was a poor Wi-Fi signal due to the remote setting of the islands. Nevertheless, a large amount of data was obtained from the process with just under 2000 responses to the survey across the six islands [33].

Figure 4: Research Poster using QR Code.

The key limitation of this strategy was the basic communications network available on the island and the absence of stakeholder commitment to collect the data for their island. This method does not allow for these factors. While the QR code worked effectively, a large amount of face-to-face interaction was needed to obtain the core sample [34]. This required the researcher to travel to each individual island more regularly than was first anticipated. The findings provided a comparative analysis of visitors' viewpoints regarding carbon off-setting in the pre-trip phase [35]. In sum, the use of the visitor survey provided key insights that highlight the practical benefits of evidenced-based planning using indicators when measuring and monitoring the impact of tourism on the six islands. In accordance with the template of the ETIS and GSTC, a twenty-two-question visitor survey was created for the purpose of this study. There were many respondents from a range of locations worldwide. This gives an indication of the levels and the extent of rich qualitative data collected using this survey method [36]. The survey instrument, Type form was used to sort and arrange the data. NVivo 14, a research software assistant, was used to obtain deeper qualitative insights. It is noteworthy that 58% of the 1,994 respondents had travelled from mainland Ireland [37]. The technology delivered a high volume of data with the average time per survey completion recorded at three minutes forty-three seconds. The survey was designed to gather data from both International and National visitors to the islands using skip logic that personalized the survey to each respondent [38].

Findings from the National Survey

The objective of the survey was to explore the visitor's viewpoint toward carbon off-setting in the Pre-trip phase of travel to each island [39]. As evidenced-based planning is under-researched in this sector, this approach offered insights that had not previously been obtained. One of the key findings of this study was the attitudes of visitors towards carbon off-setting in the pre-trip phase [40]. Figure 4 highlights the key insights in this area. It is interesting to examine the responses to this question, Figure 4 shows that most visitors would prefer not to discuss their approach to carbon off-setting. Common elements indicated that there was little interest in the practice from those surveyed. Many respondents also indicated that they didn't understand carbon off-setting and did not know how to do it [41]. Figure 5 sheds light on the most popular responses regarding the lack of carbon off-setting. Most respondents believed that carbon off-setting was difficult and couldn't understand the concept. Moreover, 21% of visitors didn't agree with the activity [42]. It was found that there was a level of mistrust surrounding carbon off-setting with 4 % of respondents indicating that the activity was just a hoax. It was noteworthy was that those surveyed identified poor public transport to remote ferry ports as a significant drawback when off-setting [43]. Tory Island in Donegal is quite remote and has little transport infrastructure. Many Irish visitors used their own car to drive to the ferry port. Figure 6 illustrates the use of personal cars to travel to these locations.
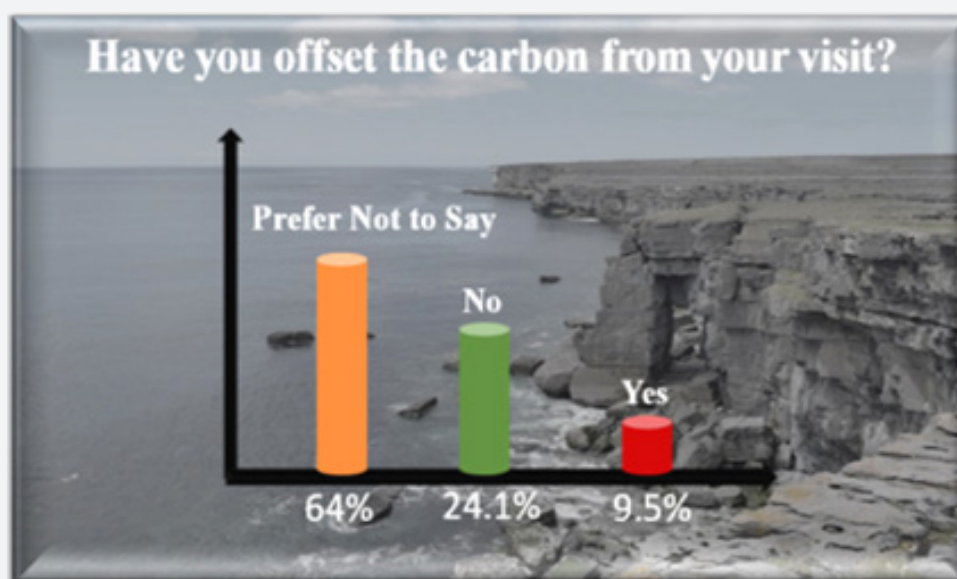

Figure 5: The Pre-Trip Approach to Carbon Off-setting by Island Visitors.

It was found that most respondents from the Irish mainland preferred to travel to the relevant ferry ports by car [44]. The thematic analysis highlighted a focus on the convenience of this mode of transport due to a poor road network system to these ports and sparse access through public transport, in particular Arran more and Tory Islands. The average journey from Dublin to any island ferry port is more than three and a half hours by car. The initial analysis resulted in the identification of factors that

influence the lack of desire to off-set carbon in the pre-trip phase [45]. There were six main counties that visitors travelled from to each ferry port, this is illustrated by table 2. The findings (above) combine the results of the surveys revealing the distance travelled by the island visitors and the carbon footprint of their journey.

The counties used for these calculations were based on the most common points of origin identified by the respondents [46]. The metric of CO_2 calculation is based on those recommended by the Sustainable Energy Authority of Ireland (SEAI 2022).
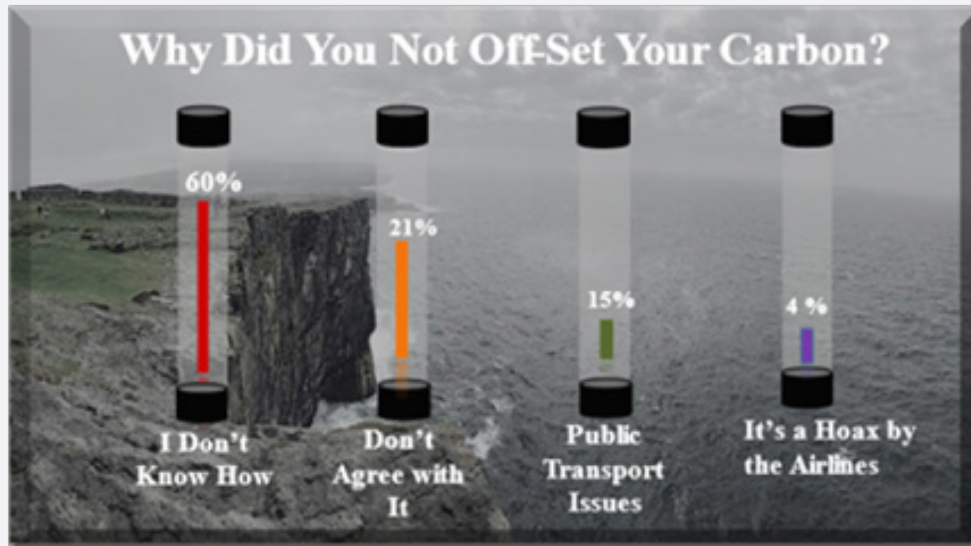

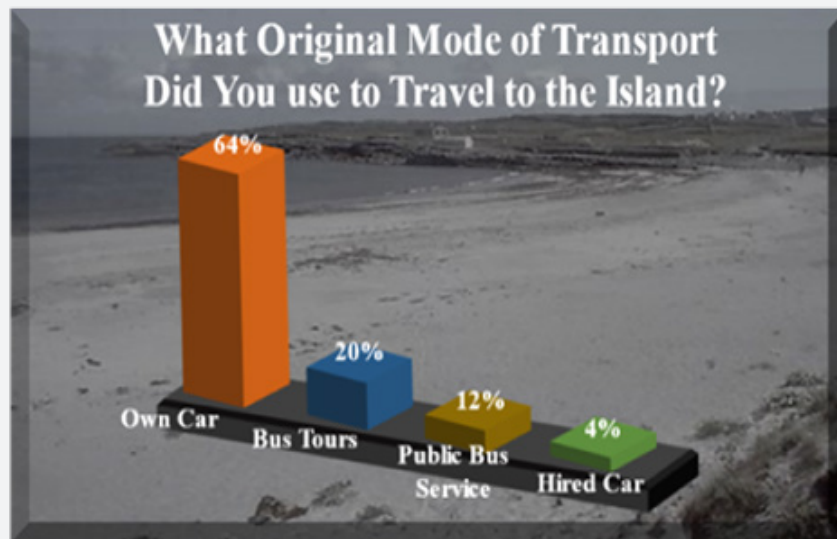**Figure 6:** Why Visitors Didn't Off-set Carbon.

Figure 7: Original Mode of Transport Used to Travel to the Islands.

International Visitors

International visitors revealed different viewpoints on carbon off-setting, with most respondents indicating that they didn't know how to off-set their carbon in the pre-trip phase. These considerations of the international visitor shed light on the lack of knowledge or information available regarding the protection of the local ecosystem. The analysis in relation to international visitors began by examining the common points of origin. Figure 7 reveals four countries based on the results of the survey [47]. The analysis regarding international visitors highlighted factors such as distance travelled to the islands, fuel consumption and the lack of carbon off-setting. The key finding is the level of emissions

generated when travelling to these island ports. Table 3 uses the SEAI (2022) CO_2 metric for airplane journeys to calculate the level of emissions generated by international tourists travelling to these island ports. Table 3 sheds light on the level of CO_2 footprint that is accumulated by international visitors when travelling to island ferry ports. The most significant finding is that the average distance travelled is a key influence on the level of CO_2 footprint created. Most international respondents indicated that they did

not off-set their carbon, thus there is a very high level of damage incurred by the Irish Ecosystem. The table above highlights the required levels of carbon that should be off-set by international visitors in the Pre-trip phase when travelling to the six islands. The average level of emissions for European visitors is 118.54 kg of carbon when travelling by plane and another mode of transport to any of the six islands [48].

Figure 8: Most Common Points of Origin for International Visitors.

Table 2: Monitoring Carbon Off-setting for National Visitors to Island Ferry Ports.

County of Origin	Island Destination Port	Avg. Length of Journey in Hours and Minutes	Distance Travelled in KM	CO2 Footprint Per Journey in KG (120g/km)
Dublin	Galway Islands	4hrs 13 mins	286	33.84
Dublin	Donegal Islands	4hrs 20 mins	291	34.92
Galway	Galway Islands	45 mins	37	4.5
Galway	Donegal Islands	4hrs 42 mins	324	38.88
Clare	Galway Islands	51 mins	44	5.3
Clare	Donegal Islands	4 hrs 28 mins	326	39.12
Cork	Galway Islands	4 hrs 23 mins	300	36
Cork	Donegal Islands	5 hrs 57 mins	447	53.64
Donegal	Galway Islands	4 hrs 5 mins	250	30
Donegal	Donegal Islands	1 hr 10 mins	78	9.4
Derry	Galway Islands	4 hrs 34 mins	320	38.4
Derry	Donegal Islands	1 hr 38 mins	60	7.2

Table 3: Monitoring Carbon Off-setting for International Visitors to Island Ferry Ports.

Country of Origin	Island Destination Port	Avg. Length of Journey in Hours and Minutes	Distance Travelled in KM by Plane	CO₂ Off-setting Per Person in KG (250 kg/km per person x 300)	Distance Travelled in KM by Bus	CO2 Off-setting Per Journey in KG (120g/km)	Total combined CO2 per Single Journey in Tonnes
USA/Dublin	Galway Islands	12hrs 13 mins	6,674	500 Mil	286	33.84 Kg	500.033
USA/Dublin	Donegal Islands	12hrs 20 mins	6,674	500 Mil	291	34.92 Kg	500.034
Great Britain/ Dublin	Galway Islands	5hrs 28mins	500	37.5 Mil	286	33.84 Kg	370.33

Great Britain/ Dublin	Donegal Islands	5hrs 57 mins	500	37.5 Mil	291	34.92 Kg	37,034
Germany/Dublin	Galway Islands	6 hrs 28 mins	1,593	119.4 Mil	286	33.84 Kg	11,983
Germany/Dublin	Donegal Islands	7 hrs 33 mins	1,593	119.4 Mil	291	34.92 Kg	119.84
France/Dublin	Galway Islands	6 hrs 18 mins	1,577	118.2 Mil	286	33.84 Kg	118.54
France/Dublin	Donegal Islands	6 hrs 17 mins	1,577	118.2 Mil	291	34.92 Kg	118.55

Recommendations

Based on the findings of this study, common elements indicate that the level of carbon emissions by visitors to these islands is still quite significant [49]. One of the key recommendations of this study would be to improve public transport and road infrastructure to these islands, particularly the Donegal islands. Local planning authorities could possibly move from a position as peripheral agents and become more present by offering carbon off-setting solutions that would be of practical benefit to these island communities [50].

Conclusion

The use of evidenced-based research has a pivotal role to play in analyzing viewpoints carbon off-setting in the Pre-trip habits of Island visitors. Using this technological approach allowed the researcher to become very specific with the data analysis. Thus, the need for a more practical approach to mitigating carbon off-setting was identified when implementing a destination management strategy for the six islands. The significant innovation of this research is the visitor's viewpoint analysis model and the key findings regarding the island visitors' attitudes towards carbon off-setting [51]. The Visitors' viewpoints encountered during the qualitative survey highlighted the need to evaluate the availability of carbon off-setting. Through the analysis of the findings, it was concluded that the best practices of measuring, monitoring and mitigating carbon footprint is the education of island visitors regarding Pre-trip travel. The key narrative of this analysis is to focus on the potential of SMART approaches when analyzing visitors' impact on the local ecosystems of small islands.

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