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Article

Exploring the application and future development of footprint calculators in the tourism industry

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Abstract: Considering the role of tourism in promoting sustainable practices in destinations, this study aims to map the scientific literature on footprint calculators in the last three years (2020–2023) with a focus on the tourism context. The method adopted is a scoping review with a qualitative and exploratory approach, using the Scopus database. The originality of this research lies in the study of publications related to footprint calculators with a focus on the tourism sector. Based on the analysis carried out, the main results show that the study of footprint calculators applied to the tourism sector has had little prominence in the indexed research in the Scopus database during the specific period considered for this study. Consequently, the conclusion of the study highlights the marginality of the tourism sector in the discussion of footprint calculators in the last 3 years of scientific publications.

Keywords: sustainable development; sustainable tourism; environmental impact; footprint calculator; carbon footprint; social footprint; water footprint; scoping review

1. Introduction

Tourism plays an important role in the global economy and in promoting sustainable practices in destinations around the world (Jones, 2023; Sustainable Travel International, 2018). With the growing awareness of the importance of sustainability, initiatives and tools have emerged to assess and mitigate the impacts of tourism activities. One such tool is the footprint calculator, which measures the impact of human actions in various sectors (Chakraborty and Roy, 2013; Leimona et al., 2024; Roussilhe et al., 2023).

Footprint calculators, including carbon ones, are widely used by companies and individuals with a sustainable mindset (Bourgeois et al., 2023; Hirvilammi et al., 2023; Jack et al., 2023; Orfanou et al., 2023; Schleich et al., 2024; Touchette and Nepomuceno, 2020).

In Europe, tourism is considered one of the most important activities for achieving neutrality in reducing the environmental footprint by 2050. In Portugal, for example, efforts such as the Turismo 2027 Strategy and the Turismo + Sustentável 20-23 Plan aim to promote sustainable practices in the tourism sector (Tourism of Portugal & NOVA Tourism and Hospitality Platform Tourism and Hospitality Platform, 2024). However, according to Jones (2023), tourism here has not yet embarked on a climate-responsible transformation.

Against this background and taking into account the scientific gap, the research was motived by two questions: How has tourism been treated in footprint calculators based on scientific publications? What do the different types of calculators have in

common that link them to the tourism sector?

Therefore, to contribute to the implementation of more sustainable tourism practices and the development of effective public policies in this sector, this research aims to map the scientific literature on footprint calculators, with a specific focus on the tourism sector, for the last three years (2021–2023).

This analysis aims to ascertain the extent and nature of research conducted on this specific topic, highlighting the current state of knowledge, and identifying gaps that could inform future research.

To gain a comprehensive understanding of the current state of research in this field, we have chosen to focus our investigation on the last three years. Although footprint calculators have been in existence for a longer period (prior to 2020), we observed a notable decline in the replication of recent studies, which suggests a gap in current research. Our conclusion regarding the marginality of tourism in discussions about footprint calculators is based on this contemporary trend, which highlights a relevant problem for science and the tourism market. Therefore, the objective of this study is not to provide an exhaustive account of the evolution of the topic under consideration, but rather to identify and analyse the specific changes that have occurred in the last three years of research on the subject. This study is of significant importance for gaining a deeper understanding the relationship between tourism and sustainable development (Bowler et al., 2024; Schleich et al., 2024).

The article is structured in six sections. The article commences with an overview of the topic subject matter, followed by an exposition of the conceptual background framework. Subsequently, the research methodology, is delineated, the results obtained are presented and a comprehensive discussion is conducted on the results. Finally, we conclude the article with a summary of the main findings and their implications.

2. Background

2.1. Sustainability

The growing awareness of the effect that human action has on the environment and the increasing scarcity of resources that are essential for human survival has put the issue of sustainability at the center of the agenda of political decision-makers (Cunha and Jesus, 2020).

Originally linked to environmental issues, the concept of sustainability has evolved to integrate the economic and social dimensions. This integration incorporates elements related to the following: (i) Integration of the present and future generations; (ii) Satisfaction of human needs; (iii) local, regional, national and global space; (iv) Human, natural, financial, institutional and technological capital; (v) Government, business, social and individual policies and practices; participatory decision-making; (vi) Development of freedoms and creation of opportunities; Inclusion, connectivity, prudence, equity and security, among others (Machado and Matos, 2020).

2.2. Footprint calculators

Footprint calculators are digital tools designed to assess the impact of human

activities (Aytac, 2023). In addition to the carbon footprint, calculators can also cover different types of footprints, including water, social, food, and sustainable footprints, among others (Cappuyns, 2024). It is also important to note that the use of different conversion factors and assumptions can result in varying footprint estimates (Cappuyns, 2024).

2.2.1. Carbon footprint calculator

In the present context, it is crucial to delineate the conceptual distinction between a carbon footprint and a carbon footprint calculator. The carbon footprint represents the environmental impact of an organization's activities, whereas the carbon footprint calculator is a specific tool utilized to measure and communicate this impact (Aytac, 2023; Bourgeois et al., 2023).

A carbon footprint calculator is a tool designed to estimate the quantity of dioxide carbon emissions resulting from a specific activity or set of activities, such as energy consumption, transportation, waste management, and deforestation. The carbon footprint calculator assists individuals, businesses, and institutions in quantifying the environmental impact their CO_2 emissions (Aytac, 2023; Wiedmann and Minx, 2008).

2.2.2. Water footprint calculator

A water footprint calculator is a tool designed to estimate the quantity of freshwater utiliized in industrial, agricultural, commercial, and household activities. The term "water footprint" is used to describe the quantity of water that is lost during a given activity, and which cannot be reused at that moment. (Hoekstra and Wiedmann, 2014; Yin et al., 2016; Hogeboom, 2020; Okutan and Akkoyunlu, 2021).

2.2.3. Social footprint calculator

Linked to social sustainability standards, social footprint calculators are tools used to assess the performance of an organization in relation to anthropocapital assets, including human, social and relationship capitals, as well as constructed and economic capitals (McElroy, 2015). In other words, it refers to the obligations that organizations have towards their stakeholders and how these obligations affect their well-being. (McElroy, 2015; Xiao et al., 2017).

3. Methodology

The scoping review method was deemed appropriate for this study as it allows for the analysis of the subject matter of the publications under review. This method differs from systematic reviews or bibliometrics, as it maps the scientific literature on a given topic of study (Kairouz et al., 2023; Munn et al., 2022). According to Munn et al. (2022), a scoping review is useful for examining emerging evidence when it is not yet clear what other more specific questions can be posed and addressed in a valuable way by a more precise systematic review. The techniques employed are qualitative and exploratory in nature, as the study aims to map the scope of scientific publications with a specific focus on tourism.

3.1. Data collection and analysis procedures

The data collected followed Arksey and O'Malley's (2005) scoping review protocol, as described below.

3.1.1. Identifying the research question

This investigation was guided by two research questions that were informed by state of the art:

1) How has tourism been approached in footprint calculators from publications in scientific databases?

2) What do the different types of calculators linked to the tourism sector and found in publications have in common?

3.1.2. Identification of relevant studies

The relevant studies for this review were identified by searching the Scopus database using the keywords "footprint calculator" (38 documents). Boolean operators were not employed, as the term "footprint calculator" is quite broad. When "AND carbon", or "AND water" or "AND social" were inserted, the resulting publications were not focused on specific discussions on the subject under investigation but were indirectly incorporated into the published studies. Consequently, only six collected documents met the selection criteria, primarily the criterion of footprint calculators directly linked to tourism.

3.1.3. Selection of the studies analyzed

The selection process involved a multistage screening process. Initially, the researchers conducted a search on Scopus from 2021 to 2023 for the terms.

"footprint calculator"—38 documents

"carbon footprint calculator"—22 documents

"water footprint calculator"—1 document

"social footprint calculator"—0 documents

It should be noted that the selection of these specific terms is justified by the direct relevance of the topic under study, the need for a targeted methodological approach and efficiency in the allocation of available resources. The data was then entered into an Excel table to create a comprehensive database on the subject.

To the inclusion and of only the most relevant and high-quality studies in the review, a set of criteria was established for the inclusion and exclusion of publications in this study. These criteria were as follows:

1) Only full articles indexed in Journals in Scopus were considered.

2) The focus of publications was on footprint calculators.

3) The publications must have been published between 2021–2023.

4) The articles were required to focus on a tourism perspective

Any articles that did not meet these criteria were automatically excluded. The data collected was then mapped and grouped into thematic categories (sets of variables) to facilitate analysis and identify emerging patterns.

3.1.4. Data analysis procedures

Finally, we proceed to the analysis and interpretation of the results. This stage entailed a detailed examination of the data in the context of the study. Furthermore, we discussed the implications of the findings for the field of study and proposed avenues for future research.

3.2. Research period

The research was conducted from January to April 2024. This study is part of a broader research project that examines the use of digital tools in the tourism sector. One such tool is the footprint calculator.

4. Results

This study considered 11 documents published in 2021, 14 documents in 2022, and 13 documents published in 2023. This corresponds to a regular flow of publications on "footprint calculator" (**Figure 1**). **Figure 1** illustrates that the number of publications reached a peak in 2022, with only two additional publications compared to 2021 and one more than in 2023.

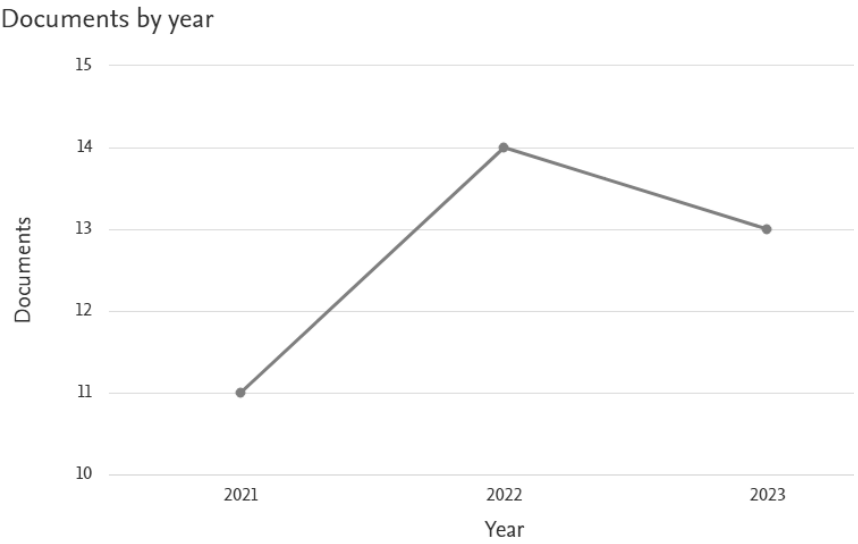

Figure 1. Publications by year.

Source: Scopus (2024).

It is also noteworthy that in 2021 two studies focused on tourism (Bekaroo et al., 2021; Kok and Barendregt, 2021), while in 2022, only one was published (Winton et al., 2022). In 2023, three studies were published. This indicates that, despite the existence of 38 publications in Scopus that address footprint calculators, only six are specifically oriented towards the field of tourism.

4.1. Focus of Scopus publications between 2021 and 2023

A review of the literature reveals that only two studies, Bekaroo et al. (2021) and Yousif and Zakaria (2022), have investigated topics directly related to tourism (**Table 1**).

The publications delineate a chronological progression of research, commencing with an emphasis on organizational and individual subjects in 2021, subsequently broadening to encompass the built environment, fuels, and inputs in 2022, and finally delving into eco-social initiatives and proposals for footprint calculators in 2023. From this timeline, it is possible to derive some insights, such as:

Table 1. Study themes.

Author	Thematic scope	Tourist scope
Bekaroo et al. (2021)	Traveling	Traveling
Yousif and Zakaria (2022)	Green roads	Green roads
Chen et al. (2022)	Built environment	
Yousif and Zakaria (2022)	Built environment	
Bokhoree et al. (2021)	Organizations	
Auger et al. (2021)	Organizations	
Scalbi et al. (2021)	Organizations	
Wassmann et al. (2022)	Inputs	
Munar et al. (2022)	Inputs	
Kouamé and Ghannadzadeh (2023)	Inputs	
Montiel et al. (2022)	Fuels	
Vieira et al. (2021)	Individuals	
Pfeifer and Borozan (2022)	Individuals	
Bekaroo et al. (2021)	Individuals	
Orfanou et al. (2023)	Individuals	
Hirvilammi et al. (2023)	Eco-social initiatives	
Scrucca et al. (2021)	Footprint calculator proposals	
Aytac (2023)	Footprint calculator proposals	
Jack et al. (2023)	Footprint calculator proposals	
Chatterjee et al. (2023)	Footprint calculator proposals	
Bourgeois et al. (2023)	Footprint calculator proposals	

1) Diversification of research topics: From 2021, a variety of topics began to be investigated, including organizations, individuals, the built environment, fuels, inputs, and eco-social initiatives. This suggests an increase in awareness and interest in understanding and mitigating environmental impacts in various areas of society.
2) Broadening the scope of research: Over time, the scope of research has expanded beyond the traditional aspects of carbon foot printing, addressing issues related to eco-social initiatives, individual and organizational behavior, and the development of assessment tools.
3) Integration of multidisciplinary approaches: The diversity of topics indicates a multidisciplinary approach to the study of the environmental footprint, incorporating not only technical and scientific aspects, but also social, behavioral and organizational considerations. This diversity reflects a more holistic understanding of environmental challenges and the need for integrated solutions.
4) Future Trends: The analysis suggests a continuing trend of expansion and diversification of research topics, with an increasing focus on social, behavioral, and political aspects related to the environmental footprint. The reality found points to future research with the potential to inform public policies, sustainable business practices and individual behavior (e.g., sustainable tourism).

With the exceltion of the studies by Pfeifer and Borozan (2022), which employed

a quantitative approach, and Jack et al. (2023), which utilized a quantitative-qualitative approach, all the other articles analyzed are qualitative in nature. While qualitative studies are valuable for gaining a nuanced understanding of footprint-related phenomena, it is crucial to acknowledge the significance of methodological diversification. The integration of mixed or complementary approaches, which combine qualitative and quantitative methods, can facilitate a more comprehensive and holistic understanding of the socio-environmental footprint and its implications. In this context, quantitative studies on footprint calculators would be valuable, given the scarcity of this scientific approach.

4.2. Predominant approaches in publications between 2021 and 2023

The predominant approaches identified in the studies were as follows:

- Carbon footprint: The carbon footprint of tourism focuses on greenhouse gas emissions from transportation/travel, accommodation, tourist activities and energy consumption.
- Water footprint: Water consumption in tourism is also an important focus, especially in regions with limited water resources, and this footprint is also related to tourism events.
- Ecological footprint: The ecological footprint, which considers various factors such as energy, land and water, offers a more comprehensive view of environmental impact and is also related to tourism.
- Social footprint: Although the behavior of society has been the focus of attention at the level of footprint calculators, only a single study (Hirvilammi et al., 2023) was found on this topic in the last three years. This scenario highlights the significance of the social footprint in the field of tourism, as well as in other areas of knowledge.

A comparison of the studies revealed that they face similar challenges and limitations when it comes to the methodologies of footprint calculators. Each author mentions different types of calculators that serve a specific purpose, and there are few publications on calculators that have a broader proposal aimed at tourism. This study found that the majority of calculators address the environmental dimension, despite the difficulty in obtaining data on resource consumption and greenhouse gas emissions in tourism, which may contribute to the lack of a more comprehensive calculator on the subject. Additionally, the assessment of social impact represents a significant challenge for the development of a tourism calculator designed to evaluate sustainability.

It is also notable that there has been an increase in demand for more sustainable form of tourism from tourists, companies, and governments. This is particularly evident in the context of the 2030 Agenda for a more sustainable world which has placed pressure the development of online tools and indicators to assess the sustainability of tourism. This has led to a growing demand for public policies that promote sustainable tourism and contribute to reducing the environmental impact of the sector.

5. Relationships between the types of calculators and the tourism sector

Although footprint calculators are valuable tools for sustainability in various sectors, their application in tourism necessitates a specific analysis of the sector's unique impacts. The tourism industry, with its complex value chain, generates a multitude of environmental and social impacts, including carbon emissions, water consumption, waste generation, and social impacts on local communities. Furthermore, this study examines the potential of footprint calculators to assess these specific impacts and to develop sustainability strategies in the tourism industry.

Of the 38 studies investigated, eleven publications are about footprint calculators related to climate action (SDG 13), suggesting important discussions for society. One such example is the growing trend in research towards practical solutions and online tools to mitigate climate change. This reflects a growing priority to address critical environmental issues and promote sustainable practices. It is significant to note that, there is a growing recognition of the significance of these tools as practical instruments for the assessment and management the environmental impact of human activities. This recognition highlights the necessity for evidence-based approaches and tangible measures to be employed to effectively address climate challenges. By focusing on footprint calculators related to climate action, studies indicate that such tools have the potential to contribute to climate change mitigation and adaptation. Consequently, footprint calculators function as instruments that facilitate the capacity of individuals, organizations, and governments to make decisions and implement efficacious measures to diminish their carbon emissions. Furthermore, the necessity of ongoing assessment of the efficacy and precision of these instruments is also a topic of discussion.

As indicated by Cardoso et al. (2022), studies with a higher Prominence Percentile are more visible and recognized within the academic community, suggesting that these studies are considered relevant and influential. Thus, of the 10 Scopus publications, four (Chatterjee et al., 2023; Jack et al., 2023; Scrucca et al., 2021; Wassmann et al., 2022) had higher percentiles (99.805 and 99.792), indicating that they are highly influential in their respective fields of research.

The publications under consideration encompass three principal domains contemporary interest: 1) Greenspace; Green Infrastructure; National Parks; 2) Meat Consumption; Diet; Livestock Products; 3) Structural Decomposition Analysis; Carbon Emissions; Material Flow Analysis. Consequently, research into these topics can facilitate the identification of solutions to significant challenges, such as climate change and environmental sustainability.

Tourism can be incorporated and analyzed from the perspective of each of the three main sets of main topics identified in this study (Scival, 2024):

1) Greenspace; Green Infrastructure; National Parks-Tourism can be a driver for the preservation and development of green spaces, such as national parks, protected nature areas and ecological reserves. Concurrently, the, tourism industry can also have a detrimental impact on green areas, including pollution, environmental degradation, and loss of biodiversity. It is of the utmost importance that tourism be developed in a sustainable way, minimizing these negative impacts and maximizing the benefits for

local communities and the environment.

2) Meat Consumption; Diet; Livestock Products-Tourism can exert a positive or negative influence on tourists' meat consumption. For instance, tourism in regions with vegetarian or vegan cultures may prompt tourists to reduce their meat consumption. Conversely, tourism in areas with cultures that prioritize meat consumption may prompt tourists to increase their consumption. It is of paramount importance that tourism promotes sustainable food options and raises awareness among tourists about the environmental impact of meat consumption, taking into account local cultures.

3) Structural Decomposition Analysis; Carbon Emissions; Material Flow Analysis-Tourism can be a significant contributor to carbon emission, particularly in relation to air and land transportation. It is important that the tourism sector implements measures to reduce its carbon emissions. Such measures should include investment in renewable energy, efficient transportation and the adoption of sustainable operating practices. Structural decomposition analysis can be a valuable tool for identifying the primary factors contributing to tourism-related carbon emissions and for directing mitigation measures.

The study conducted lends support to Raihan's (2024) assertion that the accelerated growth of tourism can result in significant environmental consequences, such as increased energy consumption. Raihan (2024) highlights the correlation between a 1% increase in economic growth, energy consumption and the number of tourist arrivals with environmental deterioration, which in turn leads to a proportional increase in CO_2 emissions. In this context, tourism-related footprint calculators play a crucial role in raising awareness of sustainability issues by calculating both the individual and collective environmental footprint of everyday activities.

The expansion of tourism contributes significantly to the global carbon footprint, primarily due to the emissions generated by air and land transportation, hospitality, and energy consumption. For example, the study by Aytac (2023) examined the carbon footprint of various tourist destinations and concluded that the collaboration of all stakeholders is essential for the mitigation of climate impacts. This study, along with others such as Bekaroo et al. (2021) and Bowler et al. (2024), demonstrates that the carbon footprint of tourism can be reduced through the implementation of measures such as optimized routes, the use of renewable fuels, and the incorporation of energy efficiency practices in hotels, restaurants, and other establishments. In this way, carbon footprint calculators can be employed to assess the environmental impact of disparate types of tourist journeys, thereby fostering the implementation of more sustainable practices by tourists and companies within the sector. It is crucial to acknowledge that with approximately 8% of global carbon emissions, attributed to tourism, the sector has a significant responsibility to mitigate this impact (Sustainable Travel International, 2024).

It is also important to contemplate the water footprint of tourism. This is due to the consumption of water for domestic purposes, irrigation, and food production. Yin et al. (2016), Hogeboom (2020), and Okutan and Akkoyunlu (2021) conducted analyses of water consumption in various tourist destinations, identifying potential avenues for the efficient management of water resources. These include craft brewing and businesses in general, including companies in the tertiary sector. Consequently,

water footprint calculators can assist tourism businesses in reducing their water consumption and adopting more effective water management practices, such as water control in hotels and restaurants.

In addition to the environmental impacts of tourism, there are also social impacts. Such consequences include the depletion of local resources, the erosion of cultural identity the rise in prices, and the exacerbation of social inequality. In their 2021 study, Okutan and Akkoyunlu (2021) analyzed the social footprint of various types of tourism and found that individual daily choices can influence the mitigation of environmental impacts. Consequently, social footprint calculators can be employed to assess these impacts and to facilitate the development of socially responsible tourism in a region.

The preceding analysis indicates that footprint calculators can be instrumental digital tools for the development of sustainable tourism public policies. Such policies may include the implementation of incentives to reduce carbon emissions, the development of water management programs, and the promotion of community tourism. For instance, tourism companies may utilize footprint calculators to assess their impacts and develop strategies for reducing their environmental and social impacts. Furthermore, footprint calculators can be employed to educate tourists about the impact of their choices and to promote the adoption of more sustainable practices during their travels. This can be achieved through the conscious use of natural resources.

The study indicates that the tourism industry would benefit from the use of footprint calculators as digital tools for the assessment and mitigation of its impacts. Consequently, companies can disseminate information on more sustainable practices and contribute to the construction of a more sustainable future for tourism.

6. Research agenda proposal

This scoping review offers a comprehensive overview of the utilization of footprint calculators within the tourism sector. The findings indicate that tourism has a considerable environmental impact, yet there are strategies that can be employed to mitigate these effects. Furthermore, the review indicates that the footprint calculator may not be a sufficient instrument for significantly reducing environmental impact. Nevertheless, these digital tools serve a pivotal function in fostering environmental awareness and education. By calculating the footprint of individual or collective activities, individuals can begin to comprehend the impact of their actions on the environment. This scenario can result in changes in sustainable behavior over time, as individuals become more aware of the environmental consequences of their choices. Over time, this awareness can result in a broader cultural shift towards more sustainable and responsible practices. This perspective aligns with that of Trabandt et al. (2024), which posits that the tourism sector has been investigating methods to diminish its environmental footprint, with footprint calculators representing a key avenue of exploration.

Consequently, footprint calculators have emerged as invaluable instruments for measuring the impact of human activity on the planet. Such calculators permit the estimation of the quantity of natural resources consumed by humans and the

greenhouse gas emissions generated by them, thereby providing a more comprehensive representation of the contemporary society's environmental responsibility. In order to ascertain the footprint of an individual or organization, a number of factors must be taken into account.

a) Energy consumption: This covers the use of electricity, natural gas, fossil fuels and other energy sources.

b) Food: Takes in account the quantity and type of food consumed, including production, transportation, and packaging.

c) Transportation: Evaluates the use of different means of transportation, such as cars, planes, and public transport, considering the greenhouse gas emissions associated with each one.

d) Goods and services: Quantify the environmental impact of the products we consume, from their production to their disposal.

e) Waste: Includes the amount of waste generated and the environmental impact of different treatment methods, such as landfill, incineration, and recycling.

In light of the aforementioned considerations, this study proposes a prospective agenda of scientific research lines focusing on specific topics, extending to sustainable practices for companies and governments. These include:

1) Development of new methodologies for calculating the tourism footprint—It is advised that tourism companies invest in research and the development of their own methodologies for calculating the footprint of their operations. This should consider the specific aspects of their business, including accommodation, transportation, food, and activities. Consequently, local public authorities may provide financial support for research aimed at developing standardised methodologies for calculating the footprint of tourism, considering the specific characteristics of different destinations and types of tourism. Furthermore, research institutions may develop online platforms and tools to assist companies, governments, destinations, and tourists in calculating their footprint (individual, corporate, or governmental) in a straightforward and efficient manner.

2) Identifying more effective measures to mitigate the socio-environmental impacts of tourism—It is possible for tourism businesses to implement sustainable management practices, such as reducing water and energy consumption, managing waste, using local products, and creating environmental education programmes for employees and guests. Local governments may also implement tax incentives and financing programmes for tourism businesses that adopt sustainable practices, as well as regulations and sustainability standards for the sector. Such measures encourage tourists to consume in a conscious and responsible manner. In this way, community tourism and ecotourism can be promoted, and tourists can be informed about the impact of their choices and best practices, thereby minimizing the impacts of tourism.

3) Investigating the impact of tourism on different destinations and types of activities, and how digital tools can reduce this impact—The utlilisation of digital tools to monitor and evaluate the impact of tourism operations allows companies to reduce their footprint and mitigate the global footprint. In this vein, local governments can develop online platforms with data on the impact of tourism in different destinations. This data can then be analyzed and compared, allowing for the creation of more effective public policies. These policies can help businesses to mitigate their impact.

Consequently, research instituitions academic bories can conduct case studies in a variety of tourist destinations to assess the impact of tourism in different contexts and developing digital solutions to mitigate negative impacts.

4) Analysis of public policies aimed at sustainable tourism using digital tools—Local governments may employ digital tools to monitor the implementation of sustainable tourism public policies, thereby collecting data on their impact and evaluating their effectiveness. Research centers and universities can contribute to this endeavor by conducting studies on the effectiveness of different sustainable tourism public policies. The studies would utilize data collected through online platforms and stakeholder surveys. Furthermore, tourism companies may utilize digital platforms to ascertain the details of public policies on sustainable tourism, thereby identifying potential avenues for investment in sustainable practices.

5) Study of the perception of "new" tourists and tourism companies about sustainability—It is possible for tourism companies to conduct surveys and evaluations with their customers to gain an understanding of their expectations and preferences in relation to sustainability. This information can then be utilized to inform the adaptation of company practices and offers to meet the identified demand. Local governments may utilize social media and digital platforms to disseminate awareness campaigns about sustainable tourism, thereby reaching a wider audience. Universities and research centers may conduct surveys with tourists and tourism companies to ascertain their perceptions, values, and expectations regarding sustainability in tourism.

6) Investigation of the potential of digital technologies for contemporary sustainable tourism—It is possible for tourism businesses to invest in digital technologies with the intention of improving operational efficiency, reducing resource consumption, optimizing supply chains, and promoting transparent communication about sustainable practices. Local governments may implement programs to provide support to tourism businesses that invest in digital technologies for sustainability. It is imperative that research organizations investigate the potential of new technologies to promote sustainability in tourism.

7) Tourism and climate change—Tourism businesses have the capacity and responsibility to develop strategies that mitigate the impact of climate change. Local governments can implement public policies designed to reduce carbon emissions in the tourism sector, facilitate adaptation to climate change, and enhance the sector's resilience. Tourists can exert influence over the selection of travel options with a reduced environmental impact. This can be achieved by selecting environmentally certified hotels and adopting a conscious approach to consumption during travel.

8) Tourism and local-regional development—Local governments can facilitate the development of public policies that promote sustainable and inclusive tourism. Tourism business can promote tourism in ways that benefit local communities. Civil society, in collaboration with universities and research centres, can support local and regional development initiatives that promote sustainable tourism and social equity.

Thus, the discussion and research agenda outlined in this study highlight the importance of the variety of footprint calculators in tourism and suggest promising directions for future research. These considerations serve as a valuable guide for guiding sustainable practices in the tourism sector and raising awareness of the

environmental impacts of tourism activities, as well as lines of inquiry for future work.

7. Conclusion

This study reviews the scientific literature on footprint calculators in tourism to highlight the growing need for tourism to be more fully integrated into socio-environmental assessment tools. It draws attention to the importance of conscious consumption practices in the sector and the need to develop strategies that take into account environmental, social, cultural and economic sustainability. Publications on the environmental footprint cover various fields of knowledge, reflecting the scientific community's concern about this impact. The application of footprint calculators is not always directly related to the context of tourism, or the relationship is not immediately obvious. However, mapping the scientific literature reveals both the ongoing discussions in society and the gaps in the scientific debate.

In this way, the proposed objective was achieved, allowing a specific scientific mapping in the field of tourism. Through this study, the researchers were able to observe that tourism is approached in two different ways. One is direct, when tourists and companies in the sector are considered as users of footprint calculators aimed at tourism. The other approach is indirect, occurring when footprint calculators are developed with a focus on areas that touch tourism, but in a peripheral way.

One of the most important findings of this study is the marginalization of tourism in the discussions of footprint calculators. This highlights the need for greater integration and consideration of tourism impacts in these socio-environmental assessment tools. Tourism-focused footprint calculators accounts have the potential to align the interests of businesses and on socio-environmental issues. However, it is important to recognize that, as Almeida et al (2018) point out, there are no fully sustainable raw materials to produce contemporary products.

7.1. Contributions

These contributions highlight the importance of promoting more conscious consumption practices in tourism and developing strategies that take into account not only environmental sustainability, but also social, cultural and economic sustainability. Engaging tourists and business in sustainable practices can make a significant contribution to preserving the environment and building a more sustainable future for all.

The results of the study provide a basis for tailoring sustainability strategies for tourism business, destinations, and stakeholders. The results of the footprint calculators' enable the identification of measures to curb of the consumption of natural resources, reduce waste generation, and mitigate the environmental impact of tourism. The results also support educational initiatives targeting tourism professionals, tourists, and local communities to raise awareness of environmental impacts and encourage the adoption of sustainable practices. Dissemination of study results to relevant government agencies can influence policy formulation in favor of sustainable tourism. In addition, leveraging partnerships with businesses, NGOs, and relevant institutions can facilitate the implementation of sustainability initiatives based on the study findings, including pilot projects and certification programs.

7.2. Implications of the research

This study provides an exploratory theoretical framework on footprint calculators for tourism. It also draws attention to the relevance of digital tools that assess the impact of human actions on the environment and society at large in the context of tourism activities.

Footprint calculators aim to monitor human actions and their impact on the surrounding environment. The multidisciplinary nature of the topic suggested by the research carried out shows that there is a concern for the preservation of the environment involving the tourist/consumer. Although the literature gives predominance to the environmental footprint, this study shows that research is already addressing issues related to the well-being of communities and workers in general, representing a starting point for further study of the social footprint imposed by tourism activity.

In practice, the results can be used by tourism companies to develop sustainability strategies and reduce their environmental impacts. At the political level, the results can be used to formulate public policies that promote sustainable tourism.

7.3. Limitations and future research

The study has limitations because it did not examine all existing scientific databases, but only the largest database in the world. For future studies, it is suggested to correlate the different fields of research and the tourism sector in the development of different footprint calculators, comparing different scientific databases. In addition, the fact that only the last three years were examined in this study can also be considered as a limitation of the study. However, this limitation is justified by the interest in recent studies on the subject under investigation.

7.4. Final considerations

Footprint calculators therefore play an important role in promoting social and environmental awareness and encouraging sustainable action, by providing people with tangible information about the impact of their activities on the environment. Despite some limitations, such as a lack of precision in certain cases, these digital tools provide an important starting point for individuals and organizations to begin reducing their impact on the planet. Tourism, as an activity that can have a significant impact on the environment, has a shared responsibility in this effort towards a more sustainable future.

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