

# On the way to sustainable energy management in tourism: Findings from a Bibliometric Study

## Hacia una Gestión Sostenible de la Energía en el Turismo: Evidencias desde un Estudio Bibliométrico

Raúl Torres-Sainz<sup>1\*</sup>, Carlos Alberto Trinchet-Varela<sup>2</sup>, Lidia María Pérez-Vallejo<sup>3</sup> and Julio-César Borrero-Neninger<sup>4</sup>

1 M.Sc. CAD/CAM study centers, Holguín University, Holguín, Cuba.

2 Ph.D., CAD/CAM study centers, Holguín University, Holguín, Cuba.

3 Ph.D., Department of industrial Engineering, Holguín University, Holguín, Cuba.

4 M.Sc. Engineering faculty, Holguín University, Holguín, Cuba.

\* Corresponding author: rtorresspro@gmail.com

Received: 2024-05-15

Accepted for publication: 2024-21-05

Published: 2024-06-30

### ABSTRACT

*Energy management in the tourism sector is essential to promote sustainable and efficient practices to reduce operating costs, mitigate environmental impact and improve the competitiveness of tourism enterprises. Despite the importance of this topic, there is a lack of bibliometric studies on energy management in the tourism sector. Therefore, the aim of this research is to map the scientific production related to this topic. To carry out this study, the bibliometric method was employed using the R package Bibliometrix to analyse indicators of productivity, impact and collaboration, extracted from the SCOPUS database. As results, a total of 201 articles published between 1977 and 2024 were identified, highlighting authors such as Acosta A, Burnett J and Park S for their prolific production and significant contributions to the field. Topics such as "Energy Management", "Energy Efficiency", "Energy Consumption" and "Sustainability" emerge as relevant and trending research topics. Furthermore, guidelines are proposed to improve energy efficiency in the tourism sector, such as the implementation of renewable energies and alternative sources such as solar, wind and biomass, as well as the adoption of intelligent energy management systems. It is concluded that future lines of research should be directed towards the use of deep learning algorithms for autonomous energy management systems in microgrids, as well as the development of systems based on the ISO 50001 standard.*

**Keywords:** Bibliometric study, Bibliometrix, Energy management, Tourism

### RESUMEN

La gestión energética en el sector turístico es esencial para fomentar prácticas sostenibles y eficientes que permitan reducir costos operativos, mitigar el impacto ambiental y mejorar la competitividad de las empresas turísticas. A pesar de la importancia de este tema, se observa una carencia de estudios bibliométricos sobre la gestión de la energía en el sector turístico. Por lo tanto, el objetivo de esta investigación es realizar un mapeo de la producción científica relacionada con esta temática. Para llevar a cabo este estudio, se empleó el método bibliométrico utilizando el paquete de R Bibliometrix para analizar indicadores de productividad, impacto y colaboración, extraídos de la base de datos SCOPUS. Como resultados se identificaron un total de 201 artículos publicados entre 1977 y 2024, destacando autores como Acosta A, Burnett J y Park S por su prolífica producción y contribuciones significativas al campo. Temas como "Energy Management", "Energy Efficiency", "Energy Consumption" y "Sustainability" emergen como relevantes y en tendencia en las investigaciones. Además, se proponen directrices para mejorar la eficiencia energética en el sector turístico, como la implementación de energías renovables y fuentes alternativas como la solar, eólica y biomasa, así como la adopción de sistemas inteligentes de gestión de energía. Se concluye que las futuras líneas de investigación deben estar dirigidas hacia el uso de algoritmos de aprendizaje profundo para sistemas autónomos de gestión de energía en microrredes, así como en el desarrollo de sistemas basados en la norma ISO 50001.

**Palabras clave:** Estudio bibliométrico, Bibliometrix, Gestión energética, Turismo

**INTRODUCTION**

The tourism industry is a crucial pillar of the global economy, contributing significantly to the economic growth and sustainable development of various regions (Hussain et al., 2024). Therefore, energy management is a vital aspect that promotes sustainability and efficiency in this sector (Torres-Sainz et al., 2022). Efficient energy use not only reduces operating costs for tourism businesses but also positively impacts carbon emissions reduction and natural resource conservation in tourism destinations (Alhawamdeh et al., 2023).

Several studies have emphasized the significance of sustainable energy use and environmental management in tourism destinations (Abbas et al., 2024; Stankov et al., 2023; Suanpang et al., 2022). The recreation and tourism industries have observed the adoption of energy-saving devices, such as energy-efficient light bulbs and solar-powered vehicles (Wang et al., 2024). Autonomous energy management systems have been proposed for effective energy management in microgrids in remote tourist areas (Luna et al., 2023). The use of modern technologies, such as the Internet of Things (IoT), can contribute to sustainable energy management in tourism destinations (Tiwari et al., 2022). Energy management systems based on the ISO 50001 standard have been proposed for the hotel industry to reduce energy-related expenses and demonstrate social responsibility (Ochoa et al., 2018; Rajić et al., 2022; Iturralde Carrera et al., 2023).

Research has shown that managers in the tourism industry still lack sufficient knowledge regarding energy issues and their impact on tourism. For instance, Ali et al. (2008) found that some hotels have installed energy-saving equipment. However, it has been observed that managers of one-star hotels are not willing to make such changes in their establishments. In contrast, hotels with ratings ranging from 2 to 5 stars have demonstrated a strong commitment to reducing energy consumption by implementing various measures.

However, it is noteworthy that there is a lack of comprehensive bibliometric studies on energy management in the tourism industry. Only two studies were found that approached energy management in tourism from a bibliometric perspective. He et al. (2022) conducted a comprehensive bibliometric review of the scientific literature on energy performance optimization of smart city components. However, the study is limited to smart cities and does not address other approaches in the tourism sector.

It is important to note that other relevant research has been published outside the scope of this study.

On the other hand, Swati and Ruby's (2023) research primarily focuses on corporate sustainability, leaving the study of environmental sustainability in tourism SMEs in an early stage. They do address secondary issues such as water and energy management, as well as circular economy. While energy management is closely related to sustainability, it is not the main focus of their research, which solely concentrates on tourism SMEs.

This knowledge gap highlights the need for a comprehensive study that maps and critically analyzes existing research in the field of energy management in tourism.

The lack of bibliometric studies on energy management in tourism provides a unique opportunity to conduct an in-depth investigation and analysis of the current state of knowledge in this area. The main objective of this research is to provide a comprehensive overview of the research conducted to date on energy management in the tourism context. This will allow for the identification of emerging trends, key areas of interest, prominent authors, and works of major impact. Furthermore, our study aims to contribute to the definition of future research directions in this interdisciplinary field by analyzing the existing scientific literature. The significance of this research is its potential to enhance the theoretical and empirical foundation of energy management in tourism. It serves as a guide for researchers, academics, industry practitioners, and policymakers interested in sustainability and energy efficiency in the tourism sector.

**METHODS**

The research employed the bibliometric analysis method. Scopus was chosen as the database due to its extensive collection of citations and abstracts of peer-reviewed literature. The search was conducted in March 2024 using the following search filter: title, abstract, or author keywords: 'Energy management' AND (tourism OR hotels OR restaurants).

The time frame was not restricted to ensure a larger pool of articles. To obtain only 'Article' type documents, a filter was applied. Relevant references were downloaded in .ris and .csv format, and a library was created in the Zotero bibliographic manager with the search results. The R pac-

kage bibliometrix was used to process the .csv file and determine bibliometric indicators of productivity, impact, co-citations, collaboration, and keyword analysis.

Productivity and impact are two important measures of research activity. Productivity refers to the number of works published by an author, research group, or institution in a given period of time. Impact, on the other hand, measures the repercussion and visibility of an academic work through citations received by other authors in their publications, indicating their influence in the scientific community (Li et al., 2024).

Co-citations are used to identify the frequency with which two papers are cited together, indicating a relationship of similarity of topics or authorship between them. However, collaboration analysis aims to identify the interaction between different authors, institutions, or countries in the production of knowledge. This allows for the identification of collaboration networks and the influence of cooperation in research (Kuhn et al., 2024).

This document measures global and local citations. Global citations are determined by the number of citations received in the database where the search was conducted, in this case, Scopus. Local citations are determined by the number of citations a document receives from the analyzed data's included documents (Aria & Cuccurullo, 2017). Global citation considers citations from a global perspective across disciplines, while local citation focuses only on citations within a specific discipline.

To measure the impact factors of journals, three different metrics are evaluated: h-index, g-index, and m-index. The h-index takes into account the number of papers from each source and the number of citations of each paper (Serrano-Leyva et al., 2022). The g-index is a measure of scientific productivity based on an author's publication history. It is calculated similarly to the h-index but is more complex and allows for differentiation between authors with similar h-indices. The m-index is defined as  $h/n$ , where h is the h-index and n is the number of years since the author's or journal's first publication (Díaz-Pompa et al., 2022; Serrano-Leyva et al., 2021).

In addition to examining the graphs generated by Bibliometrix, we conducted a thorough analysis of the corresponding data tables to enhance our understanding and interpretation of the information. These tables contain

fundamental indicators for network analysis, such as Node (representing articles or research), Cluster (thematic grouping), Betweenness Centrality (a measurement of the importance of a node in controlling information flow), Closeness Centrality (the speed of communication between a node and others), and PageRank Centrality (the relative importance of a node based on connections).

On the other hand, relevant indicators were considered for the thematic map, including occurrences (frequency of keyword usage), words (keywords used in research), cluster (thematic categorization), cluster label (thematic grouping label), and the indexes of betweenness centrality, closeness centrality, and PageRank centrality. These indicators help to assess the importance and relevance of keywords and topics within the identified thematic network. Examining these indicators in a detailed and academic manner contributes to a comprehensive understanding of the knowledge structure present in research. This allows for the identification of trends, crucial areas of interest, and the ranking of the relevance of nodes and keywords in the field of energy management in the tourism sector.

## RESULTS AND DISCUSION

### General results

Table 1 summarizes the results of the bibliometric analysis.

**Table 1: General information**

DESCRIPTION	RESULTS
<b>MAIN INFORMATION ABOUT DATA</b>	
Timespan	1977:2024
Sources (Journals, Books, etc)	109
Documents	201
Annual Growth Rate %	3,89
Document Average Age	11,7
Average citations per doc	25,69
<b>DOCUMENT CONTENTS</b>	
Keywords Plus (ID)	1550
Author's Keywords (DE)	633
<b>AUTHORS</b>	
Authors	658
Authors of single-authored docs	29
<b>AUTHORS COLLABORATION</b>	
Single-authored docs	31
Co-Authors per Doc	3,51
International co-authorships %	28,86
<b>DOCUMENT TYPES</b>	
article	201

The research on energy management in tourism covers a period from 1977 to 2024 and is based on a representative sample of 109 sources, including academic journals and specialized books. A total of 201 documents were analyzed, indicating an average annual growth of 3.89% and a growing interest in this field over time. On average, the research is 11.7 years old, suggesting a continuity in the production of knowledge on this subject.

The analyzed academic literature shows a solid average of 25.69 citations per paper, indicating a significant level of influence and relevance. The documents contain a wealth of information, with 1550 keywords plus (id) and 633 authors' keywords (de), suggesting a diversity and breadth of topics addressed. On the other hand, the study identified a total of 658 authors, with 29 of them having worked individually on document creation. Collaboration among authors is notable, with an average of 3.51 coauthors per paper and 28.86% of international collaborations, highlighting the interdisciplinary and global nature of research in this field.

**Productivity indexes**

Figure 1 shows the annual productivity of articles in the studied field from 1977 to 2024. The number of publications fluctuates significantly over the years.

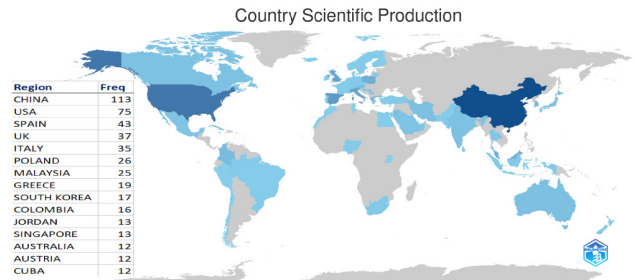
**Figure 1: Annual productivity**



Academic production in the field studied has evolved over time, with periods of greater and lesser research activity, reflecting the increasing importance and interest in studying Energy Management in Tourism.

Figure 2 provides an overview of productivity by country in scientific articles addressing energy management in the tourism sector, showing the distribution of academic production at the international level.

**Figure 2: Country Productivity**

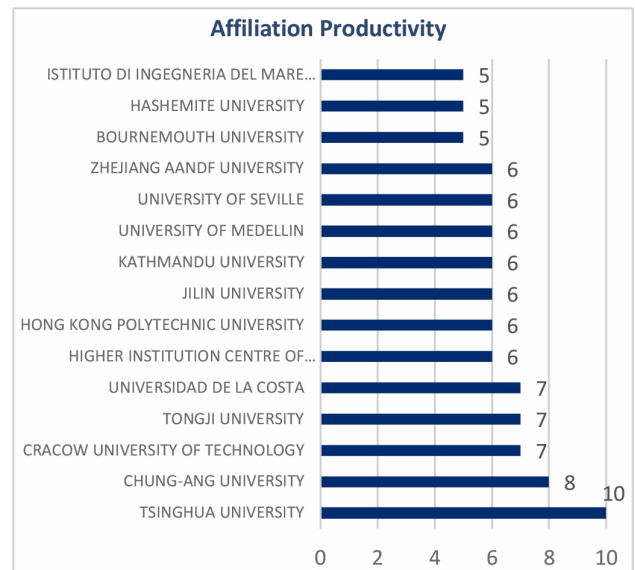


China leads with 113 publications, followed by the United States with 75, Spain with 43, and the United Kingdom with 37. Several countries have made significant contributions to the generation of knowledge at the intersection of energy management and tourism.

The World Tourism Organization (OMT), based in Madrid, Spain, promotes sustainable tourism development globally. Similarly, the International Energy Agency (IEA), located in Paris, France, focuses on energy policies and sustainable technologies. These organizations are relevant to the high scientific production in the field studied.

Figure 3 presents a detailed analysis of the productivity of scientific articles on energy management in the tourism sector, highlighting the academic institutions and organizations involved in research in this field. It is noteworthy that a diverse range of affiliations is observed, with several global institutions having a prominent presence.

**Figure 3: Affiliation Productivity**



Notably, Tsinghua University has 10 publications, Chung-Ang University has 8, and La Costa University has 7. Several institutions have made an equal number of contributions, reflecting an equal distribution in academic production in this field. However, it is worth noting that some institutions have made multiple contributions, which may indicate a strong commitment to research in energy management in tourism.

Figure 4 provides a detailed overview of productivity by journals in scientific articles addressing energy management in the tourism sector, highlighting the main sources of knowledge in this specific field. Among the most productive journals are "Energies" with 12 articles, "Energy and Buildings" and "Sustainability" with 11 articles each, followed by "Applied Energy" with 9 articles. These are sources to be considered for the socialization of scientific research results that address these topics. In addition, the identification of these sources is useful for researchers in this area to keep themselves informed and updated on high impact research.

Figure 4: Sources Productivity

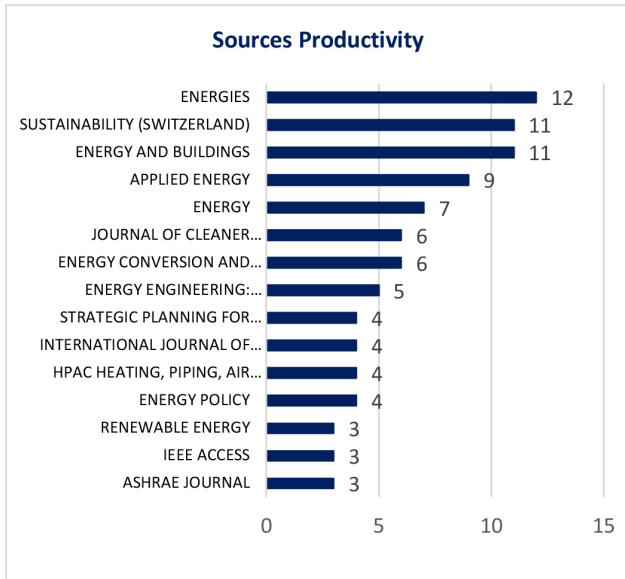
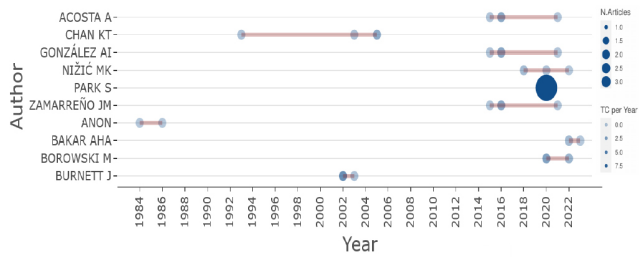


Figure 5 presents a detailed analysis of productivity by authors and citations over time, revealing the contribution and influence of authors in the field of study over different years. The data presented highlights interesting patterns in the scientific production and receipt of citations by the mentioned authors.

Figure 5: Author productivity and citations over time

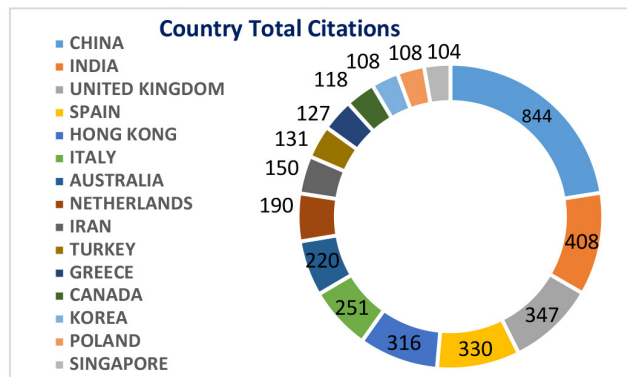


One relevant aspect of the figure is the productivity of authors, such as Acosta A, Burnett J, and Park S, who have maintained a continuous presence in the scientific literature throughout the years analyzed, with variations in the number of citations received at different times. For instance, Park S showed a significant productivity trend in 2020, receiving 45 citations, which highlights their influence during that period. These authors are recognized for their high research productivity and the quality of their work, as evidenced by the number of citations they have received. As a result, they are considered to be leading experts in the field.

Impact indexes

The analysis of citations related to energy management in the tourism sector by country provides valuable insight into the distribution of scientific production and citation reception across different regions of the world. This is illustrated in Figure 6.

Figure 6: Country Total Citations



China has the highest number of citations with 844, followed by India with 408 and the United Kingdom with 347. These data reflect the quality, relevance, and scope of the research conducted, motivating the scientific com-

munity to maintain high standards of excellence in the production of knowledge in the area of energy management in tourism.

Table 6 presents bibliometric metrics, including the h-index, g-index, and m-index, for various sources related to research on energy management in the tourism sector. These indices measure the productivity and impact of publications from each source in the field of study.

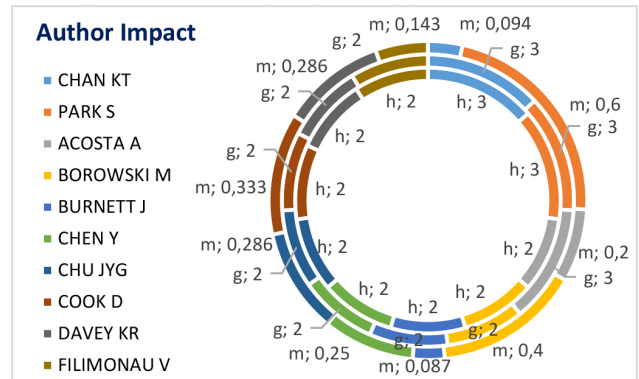
**Table 2: Source Impact**

Source	h_index	g_index	m_index
ENERGY AND BUILDINGS	11	11	0,5
APPLIED ENERGY	7	9	0,189
ENERGIES	6	12	0,462
ENERGY CONVERSION AND MANAGEMENT	6	6	0,25
JOURNAL OF CLEANER PRODUCTION	6	6	0,429
ENERGY	5	7	0,119
ENERGY POLICY	4	4	0,182
SUSTAINABILITY (SWITZERLAND)	4	8	0,364
IEEE ACCESS	3	3	0,375
RENEWABLE ENERGY	3	3	0,103
SUSTAINABLE CITIES AND SOCIETY	3	3	0,333

When interpreting this data, it is evident that journals such as 'Energy and Buildings', 'Applied Energy', and 'Energies' have relatively high h and g indexes, indicating significant influence in the scientific community. In contrast, 'Renewable Energy' and 'IEEE Access' have lower indexes compared to the previous ones. This information serves as a reference for researchers and professionals interested in accessing quality and relevant publications in sustainable energy management in the tourism sector.

Figure 7 presents metrics for the authors, allowing for identification of those with the greatest impact in this field.

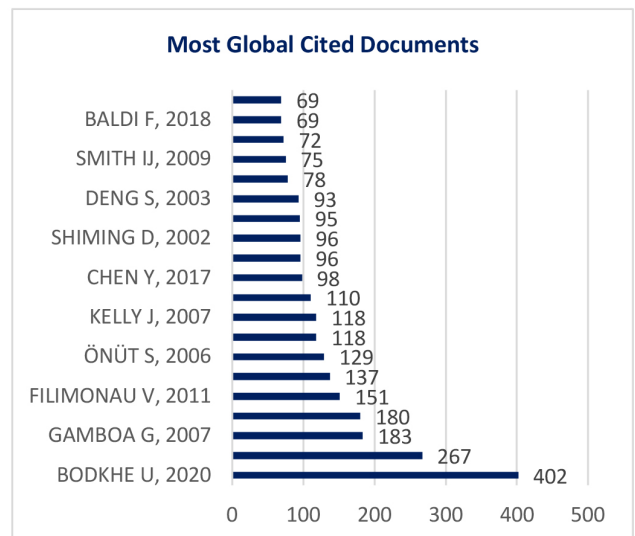
**Figure 7: Author Impact (h index; g index; m index)**



Regarding influence, the authors who stand out are Park S, Gonzalez AI, Nižić MK, Liu X, Suanpang P, Jermsittiparsert K, and Wang Q-C. These researchers have achieved a higher level of productivity and relevance in their publications compared to other authors. This is reflected in their high h and g indices, which indicate their impact and significant contribution to the scientific literature related to energy management in the tourism sector. This information is important for the academic community interested in this topic. It allows them to identify the most influential authors whose research could be relevant for their own work and future projects in this specific field of study.

Figure 8 shows the most cited global documents, which can help identify research with the greatest impact in this field.

**Figure 8: Most Global Cited Documents**

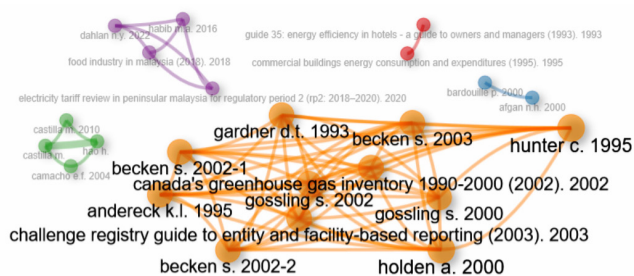




Authors such as Gossling S, whose high value of Betweenness indicates his central role in the interconnection of the network, being crucial for the linkage between other authors, stand out. Becken S and Filimonau V also emerge as relevant figures, being significantly cited in the network. These authors hold a central position in the co-citation network, indicating their influence and key role in expanding knowledge in the field of energy management in the tourism sector.

The analysis of the co-citation network between papers is shown in Figure 11, revealing the importance and centrality of certain research in the field of study.

**Figure 11: Document Co-Citations Network**



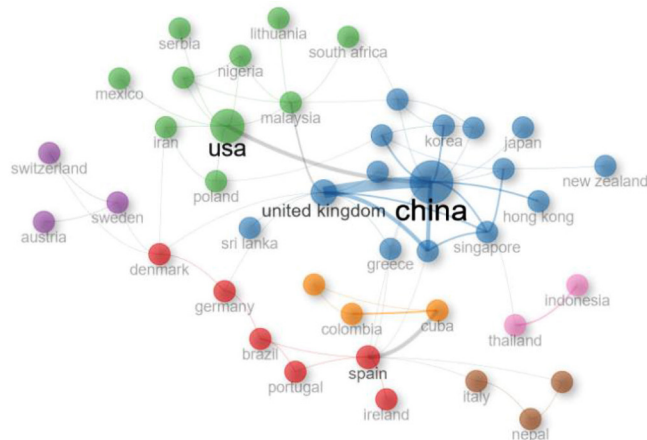
The 'Electricity Tariff Review in Peninsular Malaysia for Regulatory Period 2 of 2020' is one of the most prominent documents. These reviews are conducted regularly to analyze factors such as generation, distribution, transmission costs, energy policies, and market conditions to determine necessary adjustments in electricity tariffs. The main objective of this review is to ensure a balance between the costs of electricity supply and the tariff charged to users, creating a sustainable and efficient electricity system.

Additionally, two important papers on the web are 'Food Industry in Malaysia' from 2018 and 'Habib M.A.' from 2016. These papers demonstrate a high level of brokerage and closeness in the network, indicating that they have been widely referenced and are connected to other papers in a significant way. Furthermore, these articles have a high PageRank, indicating their significance and impact in the field of study.

**Collaboration index**

Figure 12 presents an analysis of the network of collaboration between countries, providing a detailed view of the relevance of each country in this specific area.

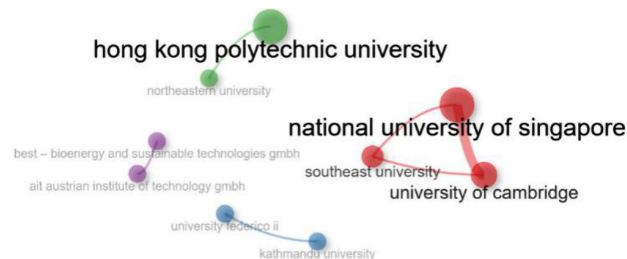
**Figure 12: International cooperation**



Spain, China, and the United Kingdom are among the most relevant countries in this network. Spain plays a central role in international collaboration in this field, particularly in intermediation. The United Kingdom also has a high level of closeness in the network, indicating a close connection with other countries in terms of collaboration. This may be due to the influence of the OMT and IEA, which are located on the European continent. These countries provide a strong foundation of knowledge and experience in energy management within the tourism sector. Their research and best practices should be consulted as a fundamental reference for future studies in this field.

Figure 13 analysis of the collaboration network between institutions provides crucial information on the most relevant entities in this field.

**Figure 13: Institutional collaborations**



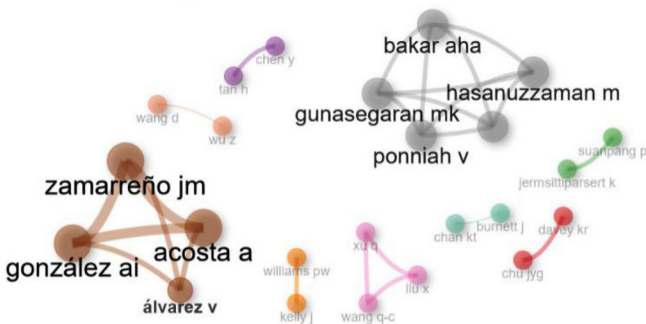
The University of Cambridge and the National University of Singapore are two of the most relevant institutions in the international collaborative network of energy management research in the tourism sector. The University of Cambridge and the National University of Singapore are two of the most relevant institutions in the international



collaborative network of energy management research in the tourism sector. They are located in the same cluster with a high level of proximity metrics and a prominent PageRank. The University of Cambridge and the National University of Singapore are two of the most relevant institutions in the international collaborative network of energy management research in the tourism sector. These institutions represent crucial points of connection and have significant influence. These institutions are recognized as leading centers of knowledge and excellence in energy management within the tourism sector. Their research and collaborations serve as a fundamental guide for future studies in this area.

Figure 14 presents an analysis of the collaboration network between authors in research on energy management in the tourism sector, highlighting the significance of certain authors in this field.

**Figure 14: Author collaboration**



Notable authors in the field of energy management research in the tourism sector include Chu JYG, Davey KR, Gruber JK, Prodanović M, Jemsittiparsert K, Suanpang P, Chen Y, Tan H, Kelly J, and Williams PW. These authors have a high PageRank, indicating significant influence on the international collaborative network. Although they do not stand out on measures such as betweenness or closeness, their work is widely referenced and has a significant impact on the field.

Additionally, the network includes authors such as Acosta A, González Al, Zamarreño JM, Álvarez V, Liu X, Wang QC, Xu Q, Bakar AHA, Gunasegaran MK, Hasanuzzaman M, Ponniah V, Tan C, Chan KT, Burnett J, Wang D, and Wu Z, who have a significant PageRank level. This places them as crucial contributors to energy management research in the tourism industry.

**Keyword analysis**

Figure 14 shows the analysis of the most frequent keywords used in research on energy management in the tourism sector, revealing recurrent and relevant themes in this field of study.

**Figure 15: Most Frequent Words**



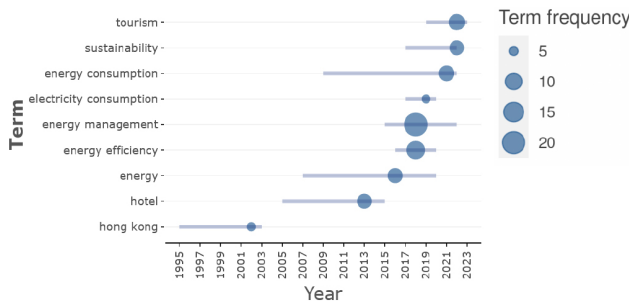
Commonly used terms in this context include 'energy management', 'energy efficiency', 'tourism', 'energy consumption', 'hotel', and 'sustainability', among others.

The frequency of terms such as 'energy management' and 'energy efficiency' in the tourism sector is due to their crucial role in optimizing energy use. This optimization is fundamental to the sustainability and profitability of operations in hotels, resorts, and other tourism establishments. These issues highlight the significance of decreasing energy consumption, optimizing energy resource efficiency, and efficiently managing energy systems in the sector to minimize costs and environmental impact.

The use of words related to sustainability, such as 'sustainability' and 'renewable energy,' indicates a growing emphasis on implementing sustainable energy practices in tourism. Recurring themes in the tourism sector include hotel energy management, energy efficiency in commercial buildings, and the importance of effective energy management strategies in the hotel industry. These aspects reflect the concern for environmental sustainability and energy efficiency.

Figure 16 displays the analysis of trending keywords. The figure illustrates the temporal evolution of the relevance of certain topics over the years.

Figure 16: Trend Topics

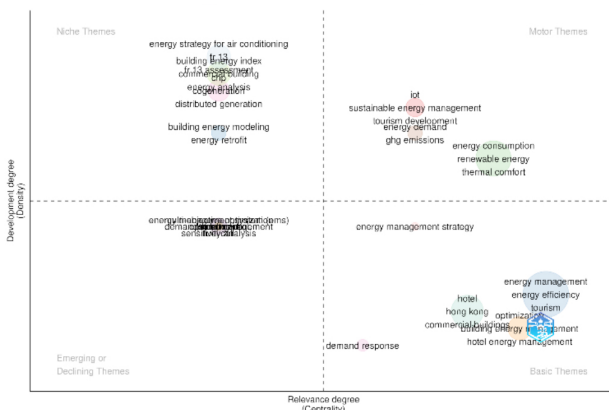


The analysis shows that 'energy management' has become a prominent topic recently, with 24 occurrences between 2015 and 2022. This indicates that energy management has become a central and growing topic of interest in tourism research in recent years, possibly due to the increasing awareness of the importance of energy efficiency and sustainability in the hospitality and tourism industry.

The trend also shows significant presence of other keywords such as 'energy efficiency', 'tourism', and 'sustainability', reflecting the increasing attention to energy efficiency, the impact of tourism on energy management, and sustainability considerations in the tourism sector. The temporal evolution of these keywords indicates that topics such as energy efficiency and sustainability have gained importance in research related to energy management in the tourism sector over the years analyzed.

Figure 17 presents the analysis of the thematic map, which reveals important aspects for understanding trends, gaps, and future lines of research in this field.

Figure 17: ThematicMap



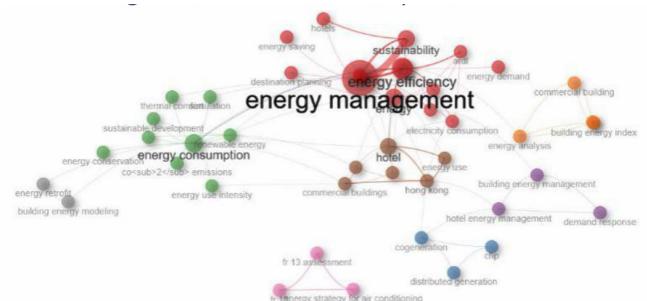
The tourism industry continues to prioritize energy efficiency, energy management, and sustainability, as evidenced by the prevalence of topics such as 'Energy Management', 'Energy Efficiency', 'Tourism', 'Energy Consumption', and 'Sustainability' in research.

The absence of keywords such as "Destination Planning", "Energy Saving", "Sensitivity Analysis" suggests areas where research could be deepened to address aspects such as tourism destination planning, energy saving strategies and sensitivity analysis in energy management in the tourism sector. "Energy Management" and "Energy Efficiency" emerge as driving themes, underlining the importance of efficient energy management in the tourism sector to achieve sustainability and resource optimization.

The analysis reveals that there is a growing interest in clean technologies and specific approaches to energy management in buildings, as evidenced by the emerging themes of 'Renewable Energy' and 'Building Energy Management'. However, the themes of 'CHP' and 'Cogeneration' appear to be losing relevance, indicating a possible shift in research focus to other areas. Important cross-cutting themes in energy management for the tourism sector include 'Optimization' and 'Multi-objective Optimization', which indicate that efficiency and optimization are key factors to consider.

The correlation analysis of keywords, as depicted in Figure 18, offers valuable insights into current trends, identified gaps, potential future research directions, as well as unexplored areas or those that could benefit from alternative approaches.

Figure 18: Co-ocurrencia de palabras clave

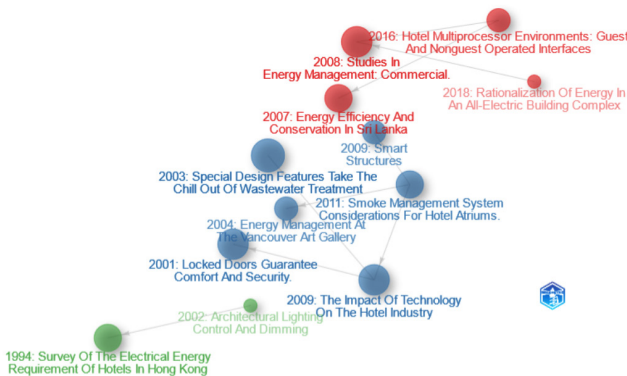


Some keywords, such as 'Building Energy Index', 'Demand Response', and 'Distributed Generation', present low or zero correlation values. This suggests possible underdeveloped areas in tourism energy management research

that may require further attention to fill possible gaps. Possible areas for future research in the tourism sector include 'Support Vector Regression', 'Energy Strategy for Air Conditioning', and 'Energy Retrofit'. These topics offer opportunities to explore innovative approaches to energy management.

The historiographic network analysis of research on energy management in the tourism sector, as shown in Figure 15, illustrates the evolution and interconnectedness of key topics addressed in academic studies on this specific field. Each node in the network, representing an article or research, is linked by keywords that reflect fundamental aspects of energy management in hotels and tourism buildings.

**Figure 19: Historiograph Network**



The figure displays the interrelation of topics such as 'Energy Management', 'Electricity Consumption', 'Hotels', 'Energy Efficiency', and 'CO2 Emissions'. These topics emphasize the significance of energy efficiency, sustainability, and effective resource management in the tourism sector. The density of connections between nodes indicates the centrality and relevance of specific topics in the historical research network, highlighting established areas of study that are of significant interest to the academic community.

The historiographic network also reflects the evolution of concepts such as 'Energy Retrofit', 'Carbon Footprint Analysis', and 'Renewable Energy Resources'. This shows how research has progressed towards more comprehensive and sustainable approaches to energy management in hotels and resorts. The existence of clusters within the network indicates the presence of groups of correlated topics that may suggest specific areas of specialization or

thematic lines of research within the field of energy management in the tourism sector.

**Future research directions, limitations, and trending topics.**

The analysis of keywords and articles reveals that current and future trends in energy management in tourism involve the use of deep reinforcement learning algorithms for autonomous energy management systems in microgrids, as well as the development of ISO 50001-based energy management systems for the hospitality industry. Research is being conducted on the use of Q-learning for microgrids in the tourism industry to achieve efficient energy management.

Additionally, comprehensive energy monitoring, forecasting, and evaluation systems are being developed for hotels. These systems take into account factors such as building cooling and heating methods, weather parameters, and staff activity patterns. Additionally, studies are being conducted to create energy-saving strategies and management techniques for resort buildings. This includes considering factors such as energy utilization methods and the hygrothermal environment.

Current constraints in the hotel industry include a lack of knowledge and awareness among managers regarding the impact of energy on tourism. Furthermore, there is a shortage of comprehensive energy monitoring, forecasting, and evaluation systems for hotels, which hinders the ability to accurately predict and manage energy consumption. Additionally, accounting and finance departments have limited contributions towards advancing energy conservation practices in hotels. There is a lack of research on energy management and its accounting implications in the hotel industry, especially in developing countries. Additionally, there is a need for guidance on reducing resources and promoting sustainability-oriented innovation in tourism accommodations. These limitations emphasize the importance of continuing education for managers, the development of comprehensive energy management systems, and further research in the field of energy management in tourism.

**Guidelines for Energy Management in the Tourism Sector**

The specialized literature has identified several actions to promote efficient energy use and improve energy management in the tourism sector. These guidelines represent

a set of key strategies with the main objective of promoting sustainable and efficient practices in operating tourism facilities. Proposed measures include:

1. Implementation of renewable energies and alternative energy sources, such as solar, wind and biomass.
2. Implementation of intelligent energy management systems: Hotels are investing in intelligent systems that optimize energy consumption through artificial intelligence algorithms to regulate systems such as heating, ventilation and air conditioning (HVAC).
3. Promotion of energy efficiency as a factor of competitiveness and added value in the tourism sector.
4. Integration of energy management in the tourism value chain, including productive, agro-industrial and social aspects.
5. Development of technological tools and solutions to monitor and optimize energy consumption in tourism facilities.
6. Adoption of public policies and regulations that promote energy efficiency in the tourism sector.
7. Upgrading to GPON fiber optic networks: Upgrading to fiber optic networks can reduce costs and improve energy efficiency by avoiding the cooling costs associated with copper cabling.
8. Water savings: Do not underestimate water consumption, as it can represent a significant cost; implementing measures to reduce water consumption also contributes to improving energy efficiency.
9. Staff training and guest awareness: Training staff on the importance of energy efficiency and promoting sustainable practices among guests can make a significant difference in efforts to improve energy efficiency, as can integrating energy efficiency into companies' marketing and communication plans to increase awareness of the importance of sustainability.
10. Energy audit: Prior to any energy conservation initiative, it is critical to conduct an energy audit to identify areas of improvement and energy waste.
11. Implement green building principles in hotels and resorts, such as efficient insulation, solar panels, natural lighting and energy-saving appliances.
12. Optimize energy use by adopting efficient technologies, such as LED lighting, efficient climates, and automatic control systems.
13. Replacing older equipment with more efficient versions, especially in the area of air conditioning and refrigeration.
14. Demonstrate commitment to energy efficiency and sustainability through certifications and quality marks.

15. Establish responsible purchasing policies for energy-efficient equipment and appliances.

These guidelines aim to promote more sustainable and efficient practices in the tourism sector, contributing to the reduction of environmental impact and the promotion of responsible and balanced tourism.

## CONCLUSIONS

From a productivity standpoint, there has been a significant increase in academic production. China leads in the publication of articles in this field, followed by the United States, Spain, and the United Kingdom. Notable contributions have been made by institutions such as Tsinghua University, Chung-Ang University, and La Costa University. The most productive journals in the field are 'Energies', 'Energy and Buildings', 'Sustainability', and 'Applied Energy'. This information may be useful for researchers and tourism managers seeking to establish strategic alliances with these countries, universities, and authors for collaboration, grant opportunities, and project applications. Additionally, these journals are the primary sources of high-quality scientific information.

In the field of energy management in tourism, China has received the highest number of citations, followed by India and the United Kingdom. Journals such as 'Energy and Buildings', 'Applied Energy', and 'Energies' have high h and g indices, indicating significant influence in the scientific community. In contrast, journals like 'Renewable Energy' and 'IEEE Access' exhibit lower indices. Noteworthy authors in this field, such as Park S, Gonzalez Ai, Nižić Mk, Liu X, Suanpang P, Jermisittiparsert K, and Wang Q-C, stand out for their influence and relevance, as reflected in their high h and g indices. The most globally cited papers include Bodkhe et al. (2020), Zhou et al. (2013), and Gamboa & Munda (2007), indicating their significant impact on scientific literature.

For researchers, this data serves as a guide to research trends and the most relevant topics in energy management in tourism. It allows for the identification of the most influential authors and the most cited publications in the field, which can guide future research and collaborations. It allows for the identification of the most influential authors and the most cited publications in the field, which can guide future research and collaborations. It allows for the identification of the most influential authors and the

most cited publications in the field, which can guide future research and collaborations. For tourism managers, this information can serve as a reference when selecting energy efficiency strategies based on scientific evidence and evaluating the quality and relevance of information sources in this field.

Regarding collaborations between countries, noteworthy active participation is observed from Spain, China, and the United Kingdom, which provides evidence of significant international cooperation in the development of research in this field. As for collaborations between institutions, the University of Cambridge and the National University of Singapore stand out for their joint contribution to scientific production in energy management in tourism. Finally, the authors who collaborate the most in this field include Chu JYG, Davey KR, Gruber JK, Prodanović M, Jermisittiparsert K, Suanpang P, Chen Y, Tan H, Kelly J, and Williams PW. Their joint work promotes the advancement and consolidation of knowledge.

The analysis includes current trends, possible future lines of development, and limitations identified in the field of energy management in tourism. Guidelines have been proposed to promote efficient and sustainable energy consumption in the tourism sector. It is important to address energy consumption in this sector. These guidelines include implementing renewable energies, using smart technologies, and raising awareness on energy efficiency.

This information is useful for both tourism managers and researchers in the field. It provides a framework for improving energy management in their facilities, which can lead to long-term economic savings, reduced environmental impact, and increased competitiveness. The guidelines for implementing energy efficiency measures are clear and practical. For researchers, this information provides guidance on the most relevant and promising areas of research in the field of energy management in tourism. It allows them to identify gaps in knowledge and innovative approaches for future studies.

## REFERENCES

- Abbas, J., Mamirkulova, G., Al-Sulaiti, I., Al-Sulaiti, K. I., & Dar, I. B. (2024).** Mega-infrastructure development, tourism sustainability and quality of life assessment at world heritage sites: Catering to COVID-19 challenges. *Kybernetes*. Scopus. <https://doi.org/10.1108/K-07-2023-1345>
- Alhawamdeh, H., Al-Saad, S. A., Almasarweh, M. S., Al-Hamad, A. A.-S. A., Bani Ahmad, A. Y. A., & Ayasrah, F. T. M. (2023).** The Role of Energy Management Practices in Sustainable Tourism Development: A Case Study of Jerash, Jordan. *International Journal of Energy Economics and Policy*, 13(6), 321–333. Scopus. <https://doi.org/10.32479/ijeeep.14724>
- Ali, Y., Mustafa, M., Al-Mashaqbah, S., Mashal, K., & Mohsen, M. (2008).** Potential of energy savings in the hotel sector in Jordan. *Energy Conversion and Management*, 49(11), 3391–3397. Scopus. <https://doi.org/10.1016/j.enconman.2007.09.036>
- Aria, M., & Cuccurullo, C. (2017).** bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, 11(4), 959–975. <https://doi.org/10.1016/j.joi.2017.08.007>
- Bodkhe, U., Tanwar, S., Parekh, K., Khanpara, P., Tyagi, S., Kumar, N., & Alazab, M. (2020).** Blockchain for Industry 4.0: A comprehensive review. *IEEE Access*, 8, 79764–79800. Scopus. <https://doi.org/10.1109/ACCESS.2020.2988579>
- Deng, S. (2003).** Energy and water uses and their performance explanatory indicators in hotels in Hong Kong. *Energy and Buildings*, 35(8), 775–784. Scopus. [https://doi.org/10.1016/S0378-7788\(02\)00238-4](https://doi.org/10.1016/S0378-7788(02)00238-4)
- Díaz-Pompa, F., Serrano-Leyva, B., Feria-Velázquez,**

- quez, F. F., & Cruz-Aguilera, N. (2022).** BIBLIOMETRIC STUDY ABOUT CULTURAL TOURISM IN SCOPUS. FUTURE RESEARCHS LINES. Bibliotecas, Anales de Investigacion, 18(3). Scopus. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85143119670&partnerID=40&md5=dce710a63de86e7e5371dbe171fb9da2>
- Gamboa, G., & Munda, G. (2007).** The problem of wind-farm location: A social multi-criteria evaluation framework. Energy Policy, 35(3), 1564–1583. Scopus. <https://doi.org/10.1016/j.enpol.2006.04.021>
- Hussain, S., Ullah, A., Khan, N. U., Syed, A. A., & Han, H. (2024).** Tourism, transport energy consumption, and the carbon dioxide emission nexus for the USA: Evidence from wavelet coherence and spectral causality approaches. International Journal of Sustainable Transportation, 18(2), 168–183. Scopus. <https://doi.org/10.1080/15568318.2023.2259337>
- Iturralde Carrera, L. A., Álvarez González, A. L., Rodríguez-Reséndiz, J., & Álvarez-Alvarado, J. M. (2023).** Selection of the Energy Performance Indicator for Hotels Based on ISO 50001: A Case Study. Sustainability (Switzerland), 15(2). Scopus. <https://doi.org/10.3390/su15021568>
- Kuhn, V. R., Gadotti dos Anjos, S. J., & Krause, R. W. (2024).** Innovation and creativity in gastronomic tourism: A bibliometric analysis. International Journal of Gastronomy and Food Science, 35. Scopus. <https://doi.org/10.1016/j.ijgfs.2023.100813>
- Li, Z., Huo, M., Huo, T., & Luo, H. (2024).** Digital tourism research: A bibliometric visualisation review (2002–2023) and research agenda. Tourism Review, 79(2), 273–289. Scopus. <https://doi.org/10.1108/TR-03-2023-0176>
- Luna, M., La Tona, G., Accetta, A., Pucci, M., Pietra, A., & Di Piazza, M. C. (2023).** Optimal Management of Battery and Fuel Cell-Based Decentralized Generation in DC Shipboard Microgrids. Energies, 16(4). Scopus. <https://doi.org/10.3390/en16041682>
- Ochoa, G. V., Cardenas, Y., & Meriño, L. (2018).** Application of equivalent occupation method as a tool for energy management in hotel sector. International Journal of Energy Economics and Policy, 8(5), 187–192. Scopus. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85053011963&partnerID=40&md5=7f62910d3d6ef0946c347747a4c17f00>
- Papamarcou, M., & Kalogirou, S. (2001).** Financial appraisal of a combined heat and power system for a hotel in Cyprus. Energy Conversion and Management, 42(6), 689–708. Scopus. [https://doi.org/10.1016/S0196-8904\(00\)00101-1](https://doi.org/10.1016/S0196-8904(00)00101-1)
- Priyadarsini, R., Xuchao, W., & Eang, L. S. (2009).** A study on energy performance of hotel buildings in Singapore. Energy and Buildings, 41(12), 1319–1324. Scopus. <https://doi.org/10.1016/j.enbuild.2009.07.028>
- Rajić, M. N., Maksimović, R. M., & Milosavljević, P. (2022).** Energy Management Model for Sustainable Development in Hotels within WB6. Sustainability (Switzerland), 14(24). Scopus. <https://doi.org/10.3390/su142416787>
- Reinders, A. H. M. E., Vringer, K., & Blok, K. (2003).** The direct and indirect energy requirement of households in the European Union. Energy Policy, 31(2), 139–153. Scopus. [https://doi.org/10.1016/S0301-4215\(02\)00019-8](https://doi.org/10.1016/S0301-4215(02)00019-8)
- Serrano-Leyva, B., Díaz-Pomp, F., Feria-Velázquez, F. F., & Richards, G. (2021).** Bibliometric study of creative tourism, tendencies and future lines of research. Biblios, 82, 64–86. Scopus. <https://doi.org/10.5195/biblios.2021.979>

- Serrano-Leyva, B., Díaz-Pompa, F., Feria-Velázquez, F. F., Serrano-Leyva, B., Díaz-Pompa, F., & Feria-Velázquez, F. F. (2022).** Innovation and creativity in the tourist offer: Challenges and perspectives for Holguin tourism destination, Cuba. *Revista Interamericana de Ambiente y Turismo*, 18(2), 236–247. <https://doi.org/10.4067/S0718-235X2022000200236>
- Stankov, U., Vujičić, M. D., & Carmer, A. B. (2023).** Impacts of energy communities on tourism: Benefits and functions towards green transition. *Tourism Review*. Scopus. <https://doi.org/10.1108/TR-05-2023-0347>
- Suanpang, P., Jamjuntr, P., Jermittiparsert, K., & Kaewyong, P. (2022).** Autonomous Energy Management by Applying Deep Q-Learning to Enhance Sustainability in Smart Tourism Cities. *Energies*, 15(5). Scopus. <https://doi.org/10.3390/en15051906>
- Swati, N., & Ruby, C. (2023).** Sustainable Tourism with Small and Medium Enterprises: A Bibliometric Analysis and Literature Review. In Mishra P., Mishra P., Sharma A., Khanra S., Kundu S.K., & Mishra S.K. (Eds.), *Springer Proc. Bus. Econ.* (pp. 391–403). Springer Nature; Scopus. [https://doi.org/10.1007/978-981-99-0197-5\\_25](https://doi.org/10.1007/978-981-99-0197-5_25)
- Tiwari, S., Rosak-Szyrocka, J., & Żywiołek, J. (2022).** Internet of Things as a Sustainable Energy Management Solution at Tourism Destinations in India. *Energies*, 15(7). Scopus. <https://doi.org/10.3390/en15072433>
- Torres-Sainz, R., Trinchet-Varela, C. A., & Pérez-Vallejo, L. M. (2022).** Mapping of the scientific production on maintenance management in hotels in Scopus. *Revista Interamericana de Ambiente y Turismo*, 18, 195–206. [http://www.scielo.cl/scielo.php?script=sci\\_arttext&pid=S0718-235X2022000200195&nrm=iso](http://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0718-235X2022000200195&nrm=iso)
- Wang, D., Mei, L., Xiao, F., Song, C., Qi, C., & Song, S. (2024).** Energy management strategy for fuel cell electric vehicles based on scalable reinforcement learning in novel environment. *International Journal of Hydrogen Energy*, 59, 668–678. Scopus. <https://doi.org/10.1016/j.ijhydene.2024.01.335>
- Zhou, Z., Zhang, J., Liu, P., Li, Z., Georgiadis, M. C., & Pistikopoulos, E. N. (2013).** A two-stage stochastic programming model for the optimal design of distributed energy systems. *Applied Energy*, 103, 135–144. Scopus. <https://doi.org/10.1016/j.apenergy.2012.09.019>