The extent of overtourism in some European locations using multi-criteria decision-making methods between 2014 and 2023

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Abstract

Purpose – *Overtourism has been identified as a significant global problem with numbers of negative externalities. The purpose of this paper is to contribute to the establishment of a standard that objectively measures the extent of tourism to produce a dynamic ranking of selected European settlements, as there is a lack of studies using sophisticated statistical methods to analyse secondary data on overtourism.*

Design/methodology/approach – *The 28 selected sites, studied according to their involvement in overtourism, were ranked using multi-criteria decision-Mmaking Methods between 2014 and 2023. Rankings were calculated by VIKOR, TOPSIS and MMOORA, and an aggregate ranking was created by using the cross-entropy optimization. Additionally, the annual changes in the rankings were presented graphically using principal component analysis on a two-dimensional space, referred to as the "sites' space." Finally, the sites were clustered into three distinct groups based on their level of overtourism: less, medium and more. This was achieved through the use of the K-means algorithm.*

Findings – *Following the onset of the pandemic in 2020, there was a notable decline in overtourism. However, following the year 2021, the numbers began to rise once more, and by 2022, they had returned to their pre-pandemic levels. Among the methods, MMOORA demonstrated the most effective performance in comparison to the optimal ranking.*

Originality/value – *The applied methods with novel rank aggregation could also shed light on the most relevant indicators to overtourism. These included the number of nights spent in paid accommodation per population, the number of overnight visits per population and the number of air passengers.*

Keywords *Overtourism, Europe, Urban tourism, Sustainability, Ranking, Tourism destinations*

Paper type *Research paper*

(Information about the authors can be found at the end of this article.)

JEL classification – R11, Z30, Z32

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1. Introduction

In the second half of the 2010s, the issue of the excessive growth of tourism was increasingly discussed, with various academic studies (Dodds & Butler, 2019b; Goodwin, 2017; Alexis, 2017) and conferences focusing on overtourism. A study by experts from the European Parliament's Committee on Transport and Tourism (TRAN) analysed secondary data and focused on case studies to examine indicators of the level of tourism (Peeters *et al.*, 2018). They ultimately concluded that it is very difficult to define common indicators for overtourism due to its complex causes and effects. In their study, they have identified a number of locations that are exposed to the negative effects of excessive tourism, specifically referred to as "overtourism destinations".

Overtourism has emerged for several socio-economic reasons (Gössling *et al.*, 2020), the most important of which are the increase in global standard of living, the availability of

cheap low-cost flights, the influence of social media and the marketing and promotional activities of tourist destinations. Prior to the outbreak of the pandemic, a number of urban destinations were experiencing a considerable influx of tourists, particularly those with a rich historical and architectural heritage, as well as well-developed airport infrastructure (De la Calle-Vaquero *et al.*, 2020). The consequence of this is not only known in professional circles but also experienced by local communities, tourists and businesses. Many well-known settlements have reported overcrowding due to the presence of tourists, rising prices (both for housing and services), overburdened infrastructure, increased waste and a growing ecological footprint (Gowreesunkar & Vo-Thanh, 2020). There have also been cultural impacts, the displacement of local communities in many places, difficulties for locals to carry out their daily activities and daily tensions between visitors and residents, leading to conflicts and demonstrations (Smith *et al.*, 2021). As a result, the visitor experience has not always been perfect: overcrowding has resulted in tourists not getting the quality of experience they expected, and local hospitality has also declined (Yu & Egger, 2021).

The issue has taken on added importance in the light of recent events relating to COVID-19. As a result of COVID-19, many countries have introduced travel restrictions, including border closures, quarantine obligations and virus testing requirements, which have led to a significant reduction in international travel. A number of studies have indicated that the pandemic and related containment measures have made it particularly challenging for host areas to attract foreign tourists (Guglielminetti *et al.*, 2023). During the COVID-19 pandemic, tourism suffered a historically unprecedented decline. Overtourism seemed to be over, and many people believed it would take a decade or more for tourism to return to pre-COVID-19 levels. This was the first time that terms no-tourism (Koh, 2020), under-tourism (Mahendru *et al.*, 2024) or zero-tourism (Garcia *et al.*, 2023) were used to describe destinations that had previously been so popular with tourists.

The authors of this study argued that the importance of sustainability among tourists has increased in the years following the pandemic and that tourists are becoming more aware of environmental impacts and are looking for sustainable travel options. This suggested a need for research to analyse whether tourists' preferences have changed following the epidemic, and whether there has been a change in the locations they choose to travel to. Furthermore, there has been a lack of quantitative analysis of indicators in connection with overtourism, which can be identified as a research gap, with the exception of Amore, Falk, and Adie ((2020). In a novel approach to the qualitative methods frequently referenced in the literature, which concentrated on the relationship between residents and visitors, Amore *et al.* ((2020) have published a study that employed a quantitative analysis of the most significant visitor indicators. Amore *et al.* ((2020) examined 15 European urban locations using a composite index. The index was developed by the authors themselves based on a substantial number of indicators. The index was indirectly related to intensity and density, namely, the total number of overnight stays per relevant tourist area in km^2, the number of museum visitors per population (narrowly defined), the average annual change (in percentage) in total nights between 2009 and 2017 and the number of foreign nights per population (narrowly defined). The index was subsequently used in a ranking of the cities, with Venice in the first position, Florence in second, followed by Seville, Lisbon and Amsterdam in the top five.

There is a notable discrepancy in the analysis of mass tourism in certain municipalities, mainly due to the lack of available data. It is evident that smaller municipalities do not provide publicly available data on their economy, industry and tourism; thus, they were excluded from the analysis. However, among the destinations visited by large numbers of tourists, there are also rural locations that have no significant economic importance apart from tourism. As the most comprehensive data are available for countries, researchers tend to select them as the subject of their analysis. The phenomenon of overtourism is

manifested in distinctive ways depending on the specific urban context in question. A thorough investigation of the local circumstances and variables is crucial for comprehending the distinctive dynamics of overtourism in a specific location. This necessitates the recognition of the fact that different types of destinations, including large cities, small towns and natural attractions, are influenced in varying ways and to varying degrees (Koens *et al.*, 2018). The special feature of this quantitative study is that it focused on smaller units, mainly cities, rather than on national tourism data.

Another noteworthy aspect of the current research is its focus on a diverse range of urban destinations, covering 28 of the European destinations identified as experiencing overtourism. The combined analysis of multiple municipalities allowed the authors to present a complex and comprehensive picture of European destinations that are overvisited by tourists. Despite the fact that most of the data is only available for European Union countries, this study also examined other European cities (e.g., Reykjavik, Bergen, Edinburgh, London). The authors were aware that the phenomenon can also be observed outside of Europe, and therefore encourage worldwide research in the future. In summary, the research question of this article was as follows: To what extent are these urban sites affected by overtourism and how has this changed since the onset of the COVID-19 pandemic? In accordance with *a priori* expectations, the southern and coastal cities were more significantly affected by overtourism between 2014 and 2019. However, the focus shifted from southern to northern locations due to the impact of the global pandemic, which has been identified as a potential temporary effect. To test this hypothesis, complex statistical methods were employed, which were explained in more detail in the methodology chapter. The aim of the methodological part was to create a weighted composite indicator to rank the selected sites in terms of the extent of tourism and to monitor changes.

2. Literature review

In parallel with the pace of globalization, tourism has undergone a number of changes in recent decades. The proportion of the population able to travel and participate in tourism as a leisure activity has increased, as leisure activities have become part of everyday life. The increasing affordability of travel, especially air travel, has contributed to more and more people being able to enjoy it, even if they can afford to stay for shorter periods (Dodds & Butler, 2019a). Although the increase in the number of tourists is a significant factor in the phenomenon of overtourism, it is not synonymous with mass tourism. Indeed, there are settlements that can accommodate large numbers of tourists without encountering any significant challenges, as their structural and infrastructural arrangements are conducive to such influxes. The media also plays a significant role in influencing consumer preferences, encouraging them to pursue similar experiences, engage in similar leisure activities and visit similar destinations (Gretzel, 2019). This is precisely the reason why researchers have encouraged the management of the most popular tourist destinations to de-promote, which is a specific measure to reduce tourism and its negative effects (Dodds & Butler, 2019b). Conversely, the imperative to stimulate consumption, to encourage companies to expand, to outperform their rivals, has resulted in imbalances.

Christensen's (2020) study, based on 33 qualitative interviews, suggested that Airbnb – a particularly vulnerable sharing economy in times of crisis (Chen *et al.*, 2021) – can have a significant impact on urban areas and that regulations are needed to offset the negative consequences. Celata and Romano (2020) noted that online short-term rental platforms such as Airbnb are not only expand the accommodation capacity of urban areas but also affect the relationships between residents and visitors. The conversion of homes into tourist accommodation through short-term rentals contributes to the displacement of residents from city centers. Therefore, despite the unavailability of Airbnb tourism data for the entire period under study, the authors found it useful to conduct a comparative analysis of the data from the limited number of years in question.

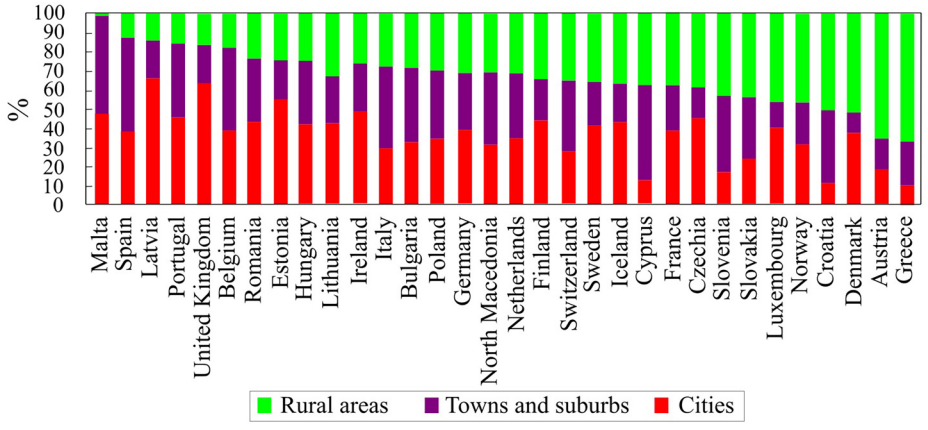
The global pandemic has had a significant impact on the tourism industry, with many popular destinations experiencing a decline in visitor numbers. The phenomenon of overtourism has been temporarily halted due to the implementation of flight cancellations, border closures and quarantine measures. In tourist destinations, the environmental impact of high visitor numbers has been reduced, allowing local communities to regenerate. Air and water quality have improved, and natural habitats have been restored. In the immediate aftermath of the global pandemic, tourists became more sensitive to crowding and safety concerns. Many tourists avoid crowds and prefer to visit less frequented locations. Some researchers expected travellers to place greater emphasis on hygiene measures, spacing and safety protocols. These new preferences are expected to influence their travel choices and destination selection (Butler & Dodds, 2022). Other researchers have stated that tourism is expected to grow again after the epidemic, raising the issue of overtourism once more (Kainthola *et al.*, 2021). In addition, others have suggested the use of innovative solutions, such as smart technologies like big data and artificial intelligence, to track and manage visitor numbers in real time. Such technologies can facilitate the sustainable management of destinations and tourist flows (Fontanari & Traskevich, 2023).

A study conducted by experts from the European Parliament's Committee on Transport and Tourism (TRAN) has identified 67 locations in Europe as overtourism destinations (Peeters *et al.*, 2018). These included entire countries (e.g. Malta), islands with numerous settlements (e.g. Mallorca), small sites (e.g. Stonehenge), typically cities or city centers. They studied these locations using a variety of statistical methods, but after a few years and using different methods, new results were obtained. It is important to highlight that this categorization distinguished between urban, coastal & islands, heritage & attraction and rural sites. However, it may not be appropriate to use this classification. As this is not a disjunctive resolution, it is not possible to clearly classify the individual settlements. On the other hand, the area of rural and coastal sites is not entirely clear and not relevant either. For this reason, the statistical analysis focused on urban areas only. In general, when investigating the extent of overtourism, the vast majority of papers also focused on urban destinations for the same reasons (Nilsson, 2020, Amore *et al.*, 2020). In addition, Żemła (2020) highlighted the increasing popularity of urban tourism and the transition to 3E (education, experience, entertainment) tourism. Hospers (2019) outlined the adverse effects of mass tourism on European cities, particularly capital cities such as Berlin, Copenhagen, Rome, Lisbon, Prague and Amsterdam. Furthermore, smaller cities with a flourishing tourism sector, including Florence, Porto, Lucerne, Salzburg, Palma de Mallorca and Dubrovnik, are also impacted.

In recent years, Eurostat (2024) has published data classifying the number of nights spent in a destination according to the degree of urbanization of the location. The institute classified local administrative units (LAUs) according to a combination of geographical contiguity and population density, and each LAU belongs to only one of these three classes only. Cities, also known as densely populated areas; towns and suburbs, also known as intermediate density areas; rural areas, also known as thinly populated areas. Urban areas include both cities as well as towns and suburbs together (densely populated areas and intermediate density areas).

Focusing on tourism data from the last year before COVID-19 (Figure 1), it can be seen that the largest share of nights spent in city accommodation was in Latvia (65.7%), the UK (63.2% in 2016) and Estonia (55.0%). Town and suburban tourism destinations were the most popular in Malta (51.8%), Spain (50.3%) and Cyprus (49.4%) in the year studied. Most nights spent in rural areas were found in Greece (66.8%), Austria (65.6%) and Denmark (52.0%). Although Malta is a rather small country in terms of surface area, it is noteworthy that 98.7% of overnight stays in Malta were in urban destinations. It is noteworthy that Spain, with one of the largest surface areas in Europe, ranks second in terms of urban overnight stays with 87.5%.

Figure 1 Share of nights spent at tourist accommodation establishments by degree of urbanization in European countries in 2019



Source: Authors' own construction based on Eurostat (2024)

This showed the importance of the type of settlement that tourists choose as their holiday destination. Although rural locations are also popular among travellers, there are few statistics available in publicly accessible databases. This forced the authors to focus their research on those settlements for which the data were available.

From a methodological standpoint, two studies were conducted on the subject of overtourism, employing the MCDM methodology (García Mestanza & Bakhat, 2021, García Mestanza & Bakhat, 2022). In their initial study, García Mestanza and Bakhat (2021) focused on rank eight municipalities from the same province and identifying the appropriate set of criteria, as determined by decision-makers based on subjective assessment. In the second study, García Mestanza and Bakhat (2022) used a range of actual data from 2010 to 2018 to rank Spain's performance over the studied period. These studies used different methodologies and an integrated approach to ranking. The present study differs from previous ones in several respects, including the use of rank aggregation, a more extended time frame that encompassed the pre- and post-pandemic periods and the inclusion of greater number of locations.

The relationship between overtourism and sustainable tourism has been the subject of investigation by other authors, who have also proposed a set of indicators for measuring this phenomenon. Indicators have been developed to assist in the identification of indications of overtourism and its consequences in urban areas. Examples of indicators include the number of visitors, congestion of tourist attractions, satisfaction of the local population, property price increases, strain on local infrastructure, seasonality, contribution of tourism to GDP, intensity of air transport and Airbnb's growth rate (De la Calle-Vaquero, García-Hernández, de Miguel, & Ferreiro-Calzada, 2020).

In a systematic literature review, Żemła (2024) identified similarities between the challenges of overtourism in various context, while also noting that these challenges are particularly pertinent to historic cities. The issues faced by historic cities in Europe diverge from those encountered by other European urban destinations, including metropolises. It is crucial to acknowledge that the objective indicators presented by the authors of this study do not fully account for the fact that metropolitan areas (e.g., London, Paris) are better equipped to cope with mass tourism than other urban destinations. The primary factor is the scale of the existing infrastructure and the degree of development of the urban transport system

(Stanchev, 2018a, 2018b). Moreover, the promotion of sustainability should not only be made available to tourists, but it can also benefit the local population. One such benefit is the promotion of sustainable forms of transportation (Torres-Delgado *et al.*, 2023).

The majority of studies that examined the issue of overtourism concluded that congestion resulting from the inflow of tourists represents a significant challenge for the municipalities in question (Amore & Adie, 2021; Torres-Delgado *et al.*, 2023). Some researchers posited that the solution to deconcentration extends beyond merely reducing seasonality, encompassing the utilization of innovative tools such as virtual tourism (e.g., virtual museum visits, escape rooms, city tours, sightseeing) to foster the emergence of alternative tourism spaces (Martins *et al.*, 2022; Farkic & Coca-Stefaniak, 2024).

In this regard, experts have access to contemporary tools, including the application of smart tourism technologies (Fontanari & Traskevich, 2023), such as real-time data analysis and monitoring of tourist flows. It is advantageous to gather historical data, formulate projections and anticipate potential issues.

It is also important to note that overvisitation cannot be measured by objective indices and indicators alone. To get a complex picture, it is also important to consider the value of the perception of overcrowding and the carrying capacity of tourism. The concept of carrying capacity, originally developed in the field of wildlife management, has been adapted for use in the context of tourism. It suggests that there are limits to the number of visitors a destination can support without suffering negative social and environmental impacts. McCool and Lime (2001) argued that the numerical carrying capacities currently in use are too simplistic and do not take into account the multiple and dynamic factors that influence the impacts of tourism. In a recent study, Tokarchuk, Barr, and Cozzio (2022) developed an innovative measure based on positive and negative sentiment indices, specifically for urban areas, based on sentiment analysis. In addition, the study of crowding perception by Neuts and Nijkamp (2012) showed that while higher levels of crowding are typically perceived as less acceptable, this perception varies considerably depending on individual preferences. Despite the difficulties in measuring it, tourism carrying capacity is a useful tool to better understand the situation in host areas (O'Reilly, 1986).

In an effort to mitigate the negative effects of overcrowding, improve tourist behavior and reduce environmental damage, European urban destinations with high visitor volume are implementing various measures. In Amsterdam, the promotion of the destination was stopped and in parallel, the promotion of less visited places was started (e.g., marketing tools, free travel tickets). The "I Amsterdam" sign, which attracted a significant numbers of visitors, was located on the Museumplein until the end of 2018 (Goodwin, 2021). However, it has been moved to a less prominent location, providing a vivid example of the removal of an artificial attraction that attracts crowds. In Rome, restrictions have been implemented on the consumption and sale of alcoholic beverages (Stanchev, 2018b), as well as a ban on bathing in fountains and walking around the city without wearing outerwear (Kryczka, 2019). A number of monuments have introduced policies requiring the purchase of an entrance ticket before visiting. In addition, prolonged stays or sitting near certain monuments, such as the Spanish Steps, have been prohibited (Celata & Romano, 2020). In Paris, the use of selfie bots has been prohibited, and the Louvre has added staff to improve the visitor experience and synchronize the timing of renovation projects across different sections to prevent overcrowding. In addition to the Louvre, other prominent cultural institutions have implemented online booking systems to regulate visitor numbers, including the Sagrada Familia in Barcelona, the Colosseum in Rome and the Acropolis in Athens (Koh, 2020). In Copenhagen, not only have quiet zones been established, but new pubs and restaurants are being restricted in areas that already have an oversupply of food outlets (Bærenholdt & Meged, 2023). In several European capitals, including Rome, Amsterdam, Reykjavik and Paris, tourist buses have been banned from the city center. This is an effective measure

when combined with the creation of bicycle lanes and the widening of sidewalks for pedestrians. A comparable solution is to increase the tourist tax rate (e.g., in Rome).

It is also noteworthy that the research employed a quantitative approach to analyze both pre- and post-Covid data, which distinguishes this article from existing literature. Although some authors have published on the topic of overtourism in the post-Covid period, no comprehensive articles have yet been published that cover multiple municipalities and a range of indicators. This constituted the research gap that was addressed in the current examination.

Koh (2020) demonstrated that the outbreak of the COVID-19 pandemic has had a profound impact on the phenomenon of overtourism, while simultaneously creating new opportunities for the realization of a more sustainable and responsible future for tourism. The author emphasized the importance of sustainability, innovation and community engagement in the context of tourism management, suggesting that these factors will be crucial in addressing the challenge of overtourism in the post-pandemic era.

In their 2021 study, Kainthola and Chowdhary used a qualitative approach to investigate tourists' perceptions of congestion in the context of the global pandemic caused by the COVID-19 virus. The research findings indicated that certain cities and destinations experienced a notable increase in tourist arrivals in the immediate post-pandemic period. There was a clear preference for less crowded, rural and natural locations over urban environments. This phenomenon led to an increased popularity of certain locations that had previously been less frequented, due to the shift in post-pandemic travel preferences. The effects of the COVD-19 pandemic are further compounded by the consequences of climate change. An increase in temperatures, alterations in rainfall patterns and a rise in the frequency of extreme weather events have a destructive impact on the tourism industry. From the standpoint of supply, climate change presents a substantial challenge to the tourism industry. From the standpoint of demand, changing climatic conditions influence tourists' destination choices (Tanriseve *et al.*, 2024). The phenomenon of climate change has resulted in a shift in the geographical range of locations that may potentially become overtouristed due to high levels of interest from tourists. This issue was also addressed in the course of the investigation.

Similarly, Pasquinelli, Trunfio, Bellini, and Rossi ((2021) sought to investigate the phenomenon of urban overtourism, with a specific emphasis on Italian cities. The article observed that, in the post-pandemic era, some lesser-known Italian cities and regions have witnessed a notable increase in tourist interest. While other studies have indicated a potential shift in urban visitation patterns following the outbreak of the COVID-19 pandemic, the majority of these studies have used qualitative research methodologies, with only a limited number of studies using quantitative data analysis. Furthermore, the aforementioned studies have not encompassed as extensive a range of urban locations as this present study. This research gap has been identified as a key area for investigation in the present study, which offered a ranking of cities based on their tourist activity in the post-COVID-19 period.

The objective of this article was to use a composite index based on existing literature (Amore *et al.*, 2020; Peeters *et al.*, 2018) to objectively rank locations and monitor changes over different time periods. This study focused on the European destinations identified by Peteers *et al.* (2018) as experiencing overvisitation. The selected destinations included a variety of locations, including several capital cities, second-largest cities, towns, rural municipalities, entire islands and provinces. It should be noted, however, that due to limitations in the data collection process, only 28 sites were ultimately selected for analysis.

3. Data and methods

3.1 Data

The data were collected from online sources, the most relevant being Oxford Economics, an independent economic consultancy (Oxford Economics, 2024) and Eurostat, the statistical

office of the European Union (Eurostat, 2023). Several of the 67 overtourism destinations in Europe identified by TRAN are small villages, rural settlements, specific attractions or smaller units (e.g. Geirangerfjord area, Plitvice Lake, Mount Vesuvius, Ring of Kerry, Stonehenge). The above-mentioned indicators are not really comparable between these categories, so the study focused only on mainly urban locations. Finally, data were available for a total of 28 destinations, which is still more than the sample of Amore *et al.* (2020). It should also be noted that in cases where the defined location was a specific part of a city or a historical city centre, the authors included the whole municipality in the study to provide data (e.g. Dubrovnik Old Town, Athens - Akropolis, Florence Historic Centre).

3.2 Indicators

Measuring overtourism can be a challenging task, but there are already indicators available that can assist experts in doing so. Buitrago and Yñiguez (2021) used relative indicators (tourist indicators/general indicators) to measure tourism intensity (e.g. tourists/residents, visitors/residents, bed-nights/residents, bed-nights/1,000 residents, cruise passengers/residents) and tourism density (e.g. tourists/km^2, bed-nights/km^2, beds/km^2). The density of tourism is commonly measured by the number of visitors, the number of overnight stays or the number of tourists per square kilometre. Meanwhile, the intensity of tourism is typically measured by the number of visitors, overnight stays or tourists per resident in the area (WTTC, 2017). For this study, the authors used the following indicators: air passengers per population, nights in paid accommodation per population, overnight visits per population, nights in paid accommodation per area, total travel spend as a percentage of GDP. To measure the extent of tourism, the present study used the same or similar measures as those used by Popescu *et al.* (2023), Maggi and Fredella (2010) and Manera and Valle (2018). Since 2020, density indicators have become more important as tourists are increasingly concerned about avoiding the risk of infection and the inconvenience of unpleasant restrictions. Avoiding congestion has therefore become a particularly important consideration for tourists, and this is reflected in the trends. On the one hand, the rationale for the selection of the indicators studied was based on the above-mentioned references. On the other hand, they were the best indicators of tourism intensity and density available in the database. Furthermore, the authors wanted to take an approach that measured the actual level/measurement/density/intensity of tourism, rather than the volume of complaints from locals in the media.

3.3 Methodology

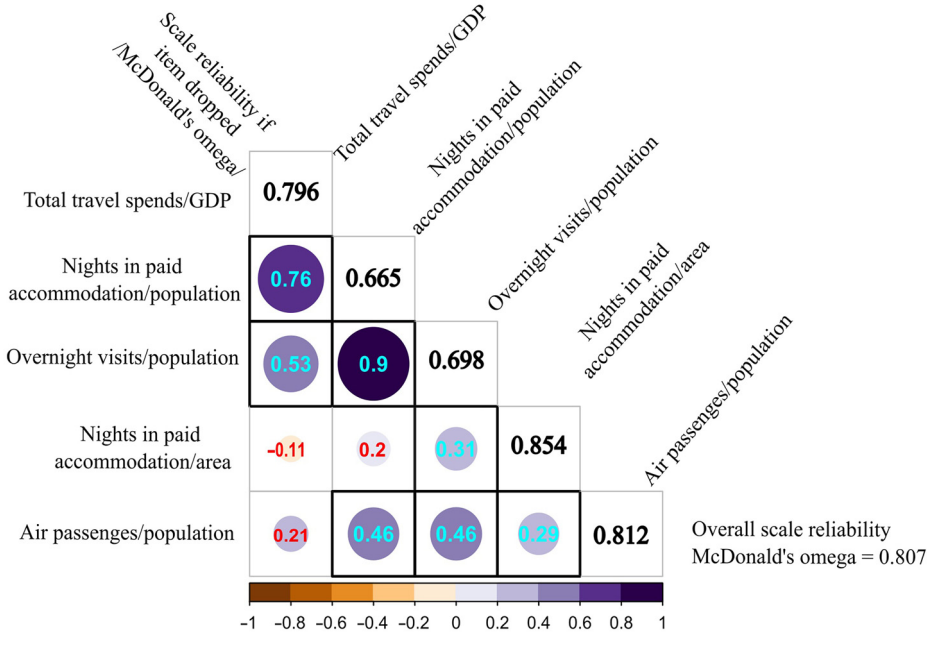
In the first phase of the research, multi-criteria decision-making (MCDM) methods were used to rank the 28 overtouristed sites according to 7 criteria (indicators) and 10 years (from 2014 to 2023). Three different ranking methods were used: TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) (Behzadian *et al.*, 2012) with vector normalization (Hwang & Yoon, 1981), VIKOR (Multi-Criteria Optimization and Compromise Programming) (Opricovic, 1998) and MOORA (Multi-Objective Optimization by Ratio Analysis) (Brauers & Zavadskas, 2009). These methods have been chosen because they are commonly used in other fields and have also been used by authors in various areas of tourism, as demonstrated by Önder, Yıldırım, and Ozdemir ((2013) and Göksu and Kaya (2014). On the other hand, they enable the user to consider whether a higher or lower value is more favourable, and to weigh up the criteria. Based on the different rankings, an aggregate ranking was created by using a fairly robust optimization algorithm called Cross-Entropy, developed by Rubinstein (1999) and Kroese, Porotsky, and Rubinstein (2006). The algorithm minimizes the following objective function (Pihur *et al.*, 2009):

$$\Phi(\delta) = \sum_{i=1}^{m} w_i . d(\delta, L_i) \quad (1)$$

where δ is the overall ranking, m is the number of criteria and L_i is the i-th rank (1<i < m). The applied distance metric is denoted by d, which in this case is the Euclidean distance, and w_i denotes the criteria weights. Several other weighting schemes were applied, and the final result was obtained using equal weights, which gave the most interpretable results. In the next step, the rankings obtained for the sites and their annual change in ranking were also presented graphically using principal component analysis (PCA) on a two-dimensional space called a biplot graph. Based on the rankings of the sites, cluster analysis was also carried out using K-means (Hartigan & Wong, 1979) and hierarchical clustering (Ward, 1963) for —two to six groups, and finally the three-group solution was selected using the NbClust optimization package and applying K-means clustering based on the so-called Silhouette index (Rousseeuw, 1987).

Finally, an ANOVA analysis was carried out on the resulting three groups to check for differences in the indicators studied. All calculations were performed with R 4.2.3. (2023–03 – 15) (R Core Team, 2023), all figures were created using R Studio 2022.02.2 (Build 485) or Excel 2016 and further enhanced using Inkscape 1.0.1. vectorized image editor. The MCDM (version 1.2) package (Ceballos Martin, 2016) was used for the MCDM method, and the CEoptim package (Benham *et al.*, 2017) was used for the cross-entropy algorithm. PCA analysis, Kaiser–Meyer–Olkin and Bartlett tests were performed using the psych package. Cluster analysis was performed using the hclust and K-means functions of the stats package.

Figure 2 Scale reliability and correlation structure of the studied indicatorsNote: The main diagonal includes the McDonald's omega if item dropped



Note: The main diagonal includes the McDonald's omega if item dropped
Source: Authors' own construction

4. Results

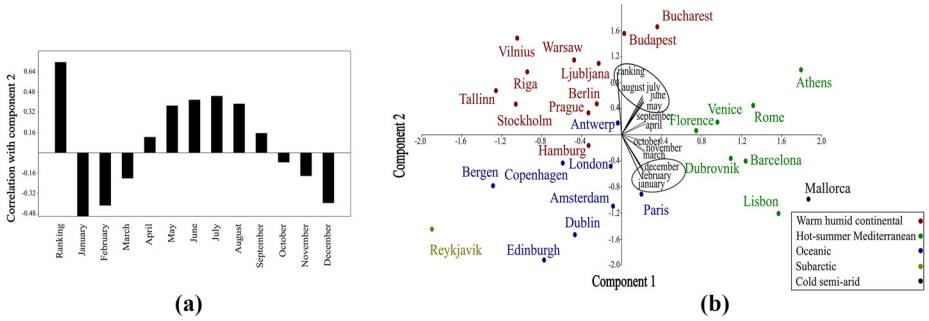
Firstly, the authors examined the internal reliability of the scale and the correlation structure between the indicators used in the ranking (Figure 2).

Figure 2 shows the pairwise Pearson correlation coefficients and the so-called McDonald's omega to measure the reliability of the scale. The overall reliability of the scale was excellent as the omega was 0.807. This indicated that the indicators selected for the analysis were measuring the same latent construct, called overtourism. The two most influential factors were "Nights in paid accommodation per population" and "Overnight visits per population" as the reliability was dropped to 0.665 and 0.698, respectively, after deleting the given item. Moreover, the greatest correlation existed between these two factors, as the correlation coefficient was 0.899 ($p < 0.001$). All correlation coefficients were significant at the 1% level, except for the value of −0.11 ($p = 0.065$)/between "Total travel spends per GDP" and "Nights in paid accommodation per area". The indicator "Total travel spends per GDP" was also strongly correlated with "Nights in paid accommodation per population"/$r = 0.762$; $p < 0.001$/and with "Overnight visits per population"/$r = 0.526$; $p < 0.001$/. The number of "Air passengers per population" was moderately correlated with "Overnight visits per population"/$r = 0.464$; $p < 0.001$/and with "total travel spends per GDP"/$r = 0.456$; $p < 0.001$.

The 28 overtourism locations were ranked with respect to the indicators shown in Figure 3 by using VIKOR, MMoora and Topsis methods for each year between 2014 and 2023. Secondly, the authors presented an intriguing and general relationship between climate/monthly average temperature and overtourism (Figure 3). In the course of the analysis, only the ranking from 2022 was used, and the monthly average temperature was calculated based on weather data from the European Centre for Medium-Range Weather Forecast (ECMWF) for the period between 1991 and 2021.

As evidenced by the second component, the overtourism ranking was related with climate and average monthly temperature. A relatively higher temperature, especially during the summer season, and a lower temperature during winter increased the ranking (in the case of less overtouristed locations), such as Riga, Stockholm, Tallinn and Vilnius. Climate was

Figure 3 PCA biplot graph of overtouristed site rankings (2022) and average temperatureNote: weather data was collected between 1991 and 2021 by the ECMWF (European Centre for Medium-Range Weather Forecast) and refreshed in May 2022. Accordingly, the ranking from 2022 was used for the analysis.



Notes: Weather data was collected between 1991 and 2021 by the ECMWF (European Centre for Medium-Range Weather Forecast) and refreshed in May 2022. Accordingly, the ranking from 2022 was used for the analysis

Source: Authors' own construction was based on data from https://en.climate-data.org/europe

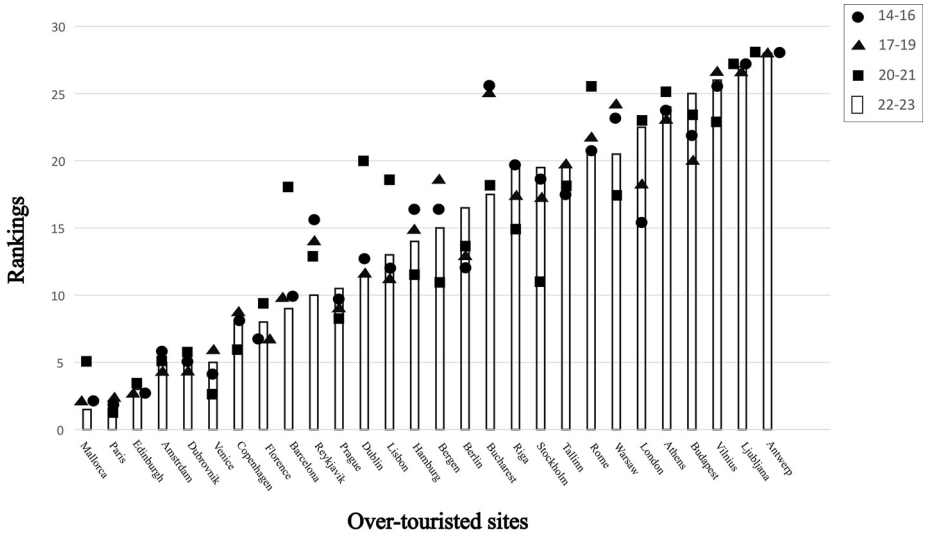
also found to be a significant factor in the overtourism ranking of a location. Locations with an oceanic and hot-summer Mediterranean climate were ranked relatively lower compared to locations with a warm humid continental climate.

The consensus ranking was then obtained by the cross-entropy optimization for each year, respectively. The rankings were averaged and presented for four different time periods between 2014 and 2023 (Figure 4).

Figure 4 shows the changes in the rankings over time. Locations were arranged from left to right according to their average ranking in 2022–2023 period. Lower rankings indicate more overtourism and higher rankings indicate less overtourism. Among the most oversisited locations, Amsterdam, Antwerp, Berlin, Dubrovnik, Edinburgh, Ljubljana, Paris and Prague showed stability in their ranking over each period. Bergen, Bucharest, Copenhagen, Hamburg, Riga, Rome, Stockholm, Venice, Vilnius and Warsaw showed fluctuations in the 2020–2021 period and ranked higher. Barcelona, Dublin, Florence, Lisbon, Mallorca and Rome also showed greater fluctuations over the 2020–2021 period and ranked lower. The largest shifts in the ranking were observed for Barcelona, Bucharest and Lisbon, which showed a significant increase in the ranking in 2020–2021, while Riga, Stockholm, and Vilnius showed a decrease between 2020 and 2021. The most visited locations were Mallorca, Paris, Edinburgh, Amsterdam, Dubrovnik and Venice. Apart from the fluctuations, Nordic cities, such as Riga, Stockholm, Tallinn and Vilnius were among the less oversisited locations as seen on Figure 5.

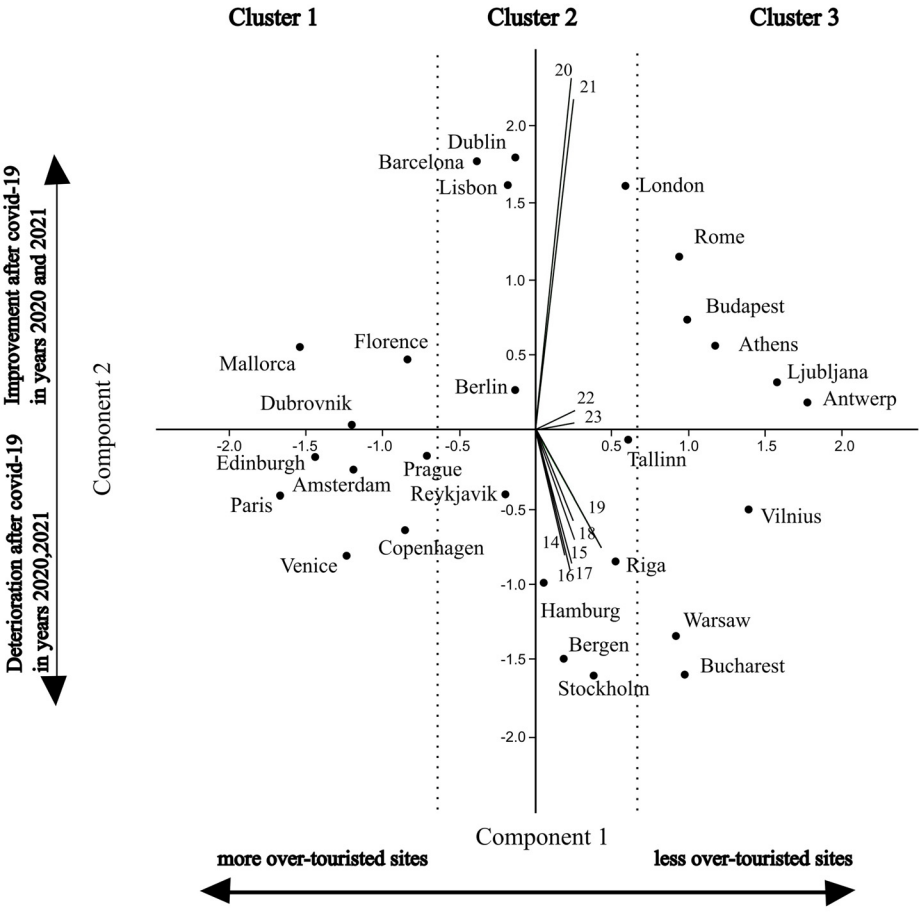
Figure 5 graphically presents the changes in the rankings from year to year, as well as the groups of the examined locations. Regarding the basic performance indicators of the PCA, the analysis was adequate and the data were appropriate for the analysis as KMO index of 0.89 was meritorious and the Bartlett test was also significant ($Chi^2 = 840$; $p < 0.001$). The explained variance by the two principal components (PCs) was 98% (larger than the required 70%) and the first principal component was the most significant as it contributed to more than 50% of the explained variance. The vectors (Figure 5) represent the relationship of each year with a given PC. The length of a vector indicates the strength of the correlation between each component and year. The direction of a vector represents the sign of the correlation.

Figure 4 Average rankings of the sites affected by overtourism in the studied periods



Source: Authors' own construction

Figure 5 PCA biplot graph of overtouristed site rankings from 2014 to 2023



Source: Authors' own construction

Component 2 primarily separated the years 2020 and 2021 from the period before the COVID-19 crisis (from 2015 to 2019). At the top, there were the sites, which showed improvement (increase in the ranking) in overtourism just after the COVID-19. At the bottom, there were sites, which became more overtouristed just after the COVID-19 as they had better rankings. Component 1 was related to mainly 2014, 2022 and 2023. At the right side of Component 1 there were the less overtouristed site, while to the left of the axis were the sites more affected by overtourism. Sites closer to the horizontal axis had more stable rankings, for example Dubrovnik, Edinburg, Reykjavik and Tallinn. Although cluster analysis is a different statistical procedure, PCA could also captured cluster structures of the data. Clusters 1, 2 and 3 can be interpreted as high, medium or low overtouristed classes. The K-means clustering algorithm was used to obtain the final cluster structure, which was found to have a higher Silhouette index (0.519) compared to hierarchical clustering (0.445). The method of cluster analysis is not unknown in the field of overtourism research. González-Reverté (2022) divided the residents of sites affected by overtourism into clusters, distinguishing three groups: tourism supporters; tourism-opposed residents; and neutral residents.

Note: short-stay accommodation data was downloaded from EURSTAT and was available between 2018 and 2023. However, due to compatibility issues, it served only supplementary

purpose and was not used in the ranking as it was not available for Dubrovnik, Edinburgh, Mallorca and London. The rationale for this decision was to maintain the analysis of these four major locations experiencing overtourism.

Table 1 present the cluster profiles and the averages of the indicators during the studied periods. One reason for the increase of urban tourism before the COVID-19 outbreak was the appearance of Airbnb and other online platforms. The Airbnb capacity is very high in some European cultural cities (Christensen, 2020), so for the sake of comparison an additional factor, short-stay accommodation via online platforms (e.g., Airbnb), was also used. This index was only covered for the period between 2018 and 2023, and only for 24 out of the 28 locations studied. Although it provided some additional information, it was not used in the ranking because the authors intended to keep the remaining four key locations (Dubrovnik, Edinburgh, Mallorca and London) for further analysis. However, the index was slightly correlated with the location ranking, as the Pearson correlation coefficient was −0.306 ($p < 0.001$). This indicated that the higher the number of nights spent in short-stay accommodations in a location, the more likely it is to be overvisited. According to the ANOVA test, the clusters showed significant differences in the indicator "Overnight visits/population" with an F-statistic of 137.19 ($p < 0.001$). In addition, the indicator "Nights in paid accommodation/population" was found to be the second most influential variable with an F-statistic of 130.55 ($p < 0.001$), followed by "Air passengers/population" with an F-statistic of 57.15 ($p < 0.001$). Thus, based on the results, it can be concluded that the strongest correlation with overtourism was observed in the number of nights spent in paid accommodation per population, followed by overnight visits per population, with air passengers being the third most significant indicator. It could also be observed that all

Table 1 Description of clusters by research indicators for each period

Cluster	*Indicator*	*Unit*	*All years*	*Period* 2014–2016	2017–2019	2020–2021	2022–2023
Cluster 1	Air passengers/population	passenger/resident	20.86	25.38	30.56	9.91	10.47
	Nights in paid accommodation/area	night/1,000 m^2	101.00	99.08	119.22	55.15	122.41
	Nights in paid accommodation/population	night/resident	22.88	23.76	27.69	10.76	26.44
	Overnight visits/population	visit/resident	6.63	6.81	8.15	3.07	7.61
	Total travel spends/GDP	US$1000/GDP	119.32	130.89	139.38	54.97	136.23
	Short-stay accommodation via online platforms*	Nights spent (million)	4.26	–	5.52	1.84	5.43
Cluster 2	Air passengers/population	passenger/resident	7.53	9.53	10.91	3.46	3.50
	Nights in paid accommodation/area	night/1,000 m^2	60.43	64.69	74.04	22.39	71.67
	Nights in paid accommodation/population	night/resident	6.71	7.23	8.13	2.96	7.55
	Overnight visits/population	visit/resident	2.89	3.10	3.50	1.33	3.26
	Total travel spends/GDP	US$1000/GDP	48.79	53.10	53.44	26.23	57.89
	Short-stay accommodation via online platforms*	Nights spent (million)	2.58	–	3.45	1.21	3.06
Cluster 3	Air passengers/population	passenger/resident	4.51	5.14	6.76	2.31	2.40
	Nights in paid accommodation/area	night/1,000 m^2	27.35	27.52	33.27	12.07	33.51
	Nights in paid accommodation/population	night/resident	3.17	3.15	3.89	1.41	3.89
	Overnight visits/population	visit/resident	1.57	1.59	1.94	0.70	1.86
	Total travel spends/GDP	US$1000/GDP	48.65	48.40	54.16	27.69	61.71
	Short-stay accommodation via online platforms	Nights spent (million)	2.04	–	2.56	0.88	2.68

Notes: *: Short-stay accommodation data was downloaded from EURSTAT and was available between 2018-2023. However, due to compatibility issues, it served only supplementary purpose and was not used in the ranking since it was not available for Dubrovnik, Edinburgh, Mallorca, and London. The rationale for this decision was to maintain the analysis of these four major locations experiencing overtourism

Source: Authors' own construction

indicators, regardless of the level of overtourism, had a decline between 2020 and 2021 and regained or exceeded their value between 2022 and 2023, compared to the period before the pandemic.

Table 2 present the performance results of the rank aggregation using randomization tests. In the randomization test, 1,000 random rankings were generated and then the Sum of Absolute Difference (SAD) values were calculated between the aggregated (optimal) ranking for each method over the entire study period. The mean and standard deviation of these values were also calculated, as well as the probability of obtaining a certain SAD value or less. If the value of p is very small, this indicates that the SAD value could not have been obtained by chance and that it was rather small and not significantly different from the optimal ranking.

As the ranking by a given method approaches the aggregate, the SAD approaches 0. The randomization test was used to show the value that was already significantly different from the aggregated value. As can be observed in Table 2, the mean value from of the test was approximately 261, with a standard deviation of 32. The most stable method was Moora, with the lowest SAD values. In terms of time periods and p-values, the ranking was not significantly different from the random values at the beginning of the COVID-19 pandemic.

5. Discussion

The fuzzy modified hybrid MCDM approach proposed by García Mestanza and Bakhat (2021) was intended to identify the relative importance of various factors in assessing the impacts of overtourism. This approach was illustrated using a local Spanish community, Malaga province, in the context of the COVID-19 outbreak. The importance of adopting a realistic set of factors to quantify the impacts of overtourism was also highlighted by the authors. The authors investigated three major criteria dimensions: economic, environmental and social factors. Among the ten factors studied, economic dependence on tourism were identified as the main influencing factors. García Mestanza and Bakhat (2022) studied the effect of the COVID-19 outbreak on Spanish tourism using an integrated CRITIC-VIKOR method. The study found that economic indicators contributed to the worsening of the tourist attitude and that the recovery of tourism indicators will be progressive from 2021. These results were in line with the present study. The researchers also stated that, despite the MCDM methodology being the most commonly used in tourism, there was no research carried out on the MCDM approach to assess overtourism, which could also be supported

Table 2 Sum of absolute ranking difference (SAD) values and randomization test results

	SAD values of each method				*Randomization test results*	
Year	*VIKOR*	*MOORA*	*TOPSIS*	*Sum*	*Mean/St.Dev.*	p-*values per method Vikor/Moora/Topsis*
2014	180**	144***	174**	498	260.6 / 30.0	0.003 / 0.001 / 0.002
2015	208*	156***	210*	574	261.5 / 31.7	0.045 / 0.001 / 0.049
2016	262	186*	202*	650	262.1 / 32.5	0.482 / 0.014 / 0.038
2017	210*	248	230	668	261.1 / 31.5	0.045 / 0.337 / 0.153
2018	246	194*	226	666	262.6 / 32.1	0.279 / 0.019 / 0.115
2019	*228*	*236*	*222*	*686*	*260.6 / 30.4*	*0.139 / 0.210 / 0.102*
2020	228	150***	200*	578	259.8 / 31.2	0.155 / 0.001 / 0.028
2021	246	150***	200*	596	261.7 / 32.6	0.306 / 0.001 / 0.033
2022	250	126***	146***	522	262.4 / 32.1	0.344 / 0.001 / 0.001
2023	268	214'	206*	688	260.1 / 31.2	0.584 / 0.074 / 0.044
Sum	2326	1804	2016			

Notes: '$p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
Source: Authors' own construction

and emphasized by this investigation. Mohammad Mahmoudi, Seyed Hojjat, and Roya ((2017) investigated the shopping behaviour of foreign tourists in Iran by using the SAW, TOPSIS and ELECTRE methods. They emphasized the necessity for integration due to methodological incompatibilities to reach a general consensus. In this present study, rank aggregation was advocated instead of an integrated or combined approach. In regard to the findings of this paper, they are in alignment with the conclusions drawn from the existing literature as follows.

Prior to the global spread of the Coronavirus, European urban centers such as Venice, Barcelona and Amsterdam experienced significant challenges related to overtourism. This phenomenon has resulted in notable environmental deterioration and social unrest among the local population. In the post-pandemic era, concerns have arisen that the tourism sector may rapidly resume its pre-pandemic levels of activity, unless significant changes are implemented. There is a call for the implementation of sustainable tourism practices to prevent a return to overtourism (Amore & Adie, 2021).

By 2020, popular urban centers in Europe had experienced a considerable inflow of tourists, leading to overtourism. The focus has shifted to the promotion of alternative urban spaces and the implementation of responsible tourism practices, with the objective of distributing visitor flows more evenly and reducing pressure on traditional tourist hotspots (Farkic & Coca-Stefaniak, 2024).

The issue of overtourism has become a significant challenge for key European destinations, largely due to the lack of adequate management systems in place. In the wake of the 2020 pandemic, there is a pressing need to implement smart solutions, such as crowd management technologies and real-time monitoring, with the aim of more effectively managing tourism and building resilience in these destinations (Fontanari & Traskevich, 2023).

In their study, Hidalgo Giralt, Palacios García, Barrado Timón, and Cea D'Ancona ((2023) concentrated solely on Spanish cities, ultimately arriving at the following conclusions. Prior to the pandemic, medium and small cities in Spain frequently experienced a considerable inflow of tourists, yet these occurrences were not as widely discussed as those in larger urban centers. In the post-pandemic era, the Tourism Intensity Index (TII) has emerged as a key tool for managing and understanding the impact of tourism in these smaller urban areas, facilitating the promotion of more tailored and sustainable tourism strategies.

Prior to the pandemic, major European cities were confronted with significant challenges, including overcrowding, environmental degradation and social tensions, as reported by Lopes, Lopes, Correia, and Portugal ((2022). After the pandemic, the emphasis has shifted towards integrating health and safety measures, digital transformation and sustainable practices to ensure a more resilient and balanced tourism sector.

Torres-Delgado, López Palomeque, Ivars-Baidal, and Vera-Rebollo ((2023) determined that before the pandemic, Spanish cities such as Barcelona were combating the issue of overtourism. Since that time, there has been a concentrated effort to identify and implement a more sustainable tourism model, which has included the introduction of a broader range of tourism products and the engagement of local communities to prevent the recurrence of overtourism.

The findings of the study aligned with those of McClanahan (2022), who posted that the growth of northern cities is attributable to climate change and heat waves. Following the pandemic, there was a notable intensification in the phenomenon of tourism phobia, accompanied by a rise in popularity for the less crowded northern cities became more popular (Frago, 2021).

These results were largely consistent with those of Amore *et al.* ((2020), although there were a few exceptions. The exceptions can be attributed to the different methodologies used and the distinct timeframes under investigation. However, the indicators did not provide an adequate measure of the extent to which the destination has been portrayed in the media as an

overtourism location. The latter is dependent to a significant extent on sensory threshold, cultural background and perceptions of individuals, which are not fully captured by these objective indicators. While there is no clear shift from southern to northern Europe, there is a noticeable trend of tourist flows spreading out to reduce pressure on the usual hotspots.

6. Conclusion

6.1 Theoretical and practical implications

The objective of this article was to contribute to the growing body of knowledge on the potential negative impacts of tourism. To this aim, the authors intended to raise awareness of the associated risks and provide insights and recommendations for mitigating these effects. In the context of overtourism, there is an urgent need to advance sustainable tourism practices. This can be accomplished through the formulation of sustainable tourism strategies at the city level, which can serve as a model for smaller cities. In cities experiencing the phenomenon of overtourism, these strategies frequently encompass restrictions on tourists (e.g. numbers, behavior), entrance fees, special permits for certain vulnerable heritage sites and the introduction or increase of tourism taxes. The authors of this paper posit that the observation and monitoring of the phenomenon, the collection of data, and its subsequent analysis can assist in the identification of early indications of overtourism based on established tourism trends. The ranking of the years before 2020 seems to be very stable, with Mallorca, Venice, Paris, Edinburgh, Dubrovnik, Amsterdam, Prague and Florence in the top positions for almost every year from 2014 to 2019. However, the first year, 2020, which was affected by COVID-19, completely overturned the ranking. Due to the restrictions and people's fears, Mallorca, which had been stable in first place until then, fell to fourth place, while Dubrovnik dropped from the podium to tenth place. Like Mallorca and Dubrovnik, Florence also dropped significantly in the ranking in 2020, but over the following three years it gradually regained its place among the cities most affected by overtourism. The impact of the COVID-19 pandemic appeared to have been transient, as patterns observed during the pandemic were largely driven by temporary factors such as travel restrictions, border closures, health concerns and changes in consumer behaviour. In 2020, there was a significant decline in overtourism due to the pandemic. After 2021, numbers started to rise again, and after 2022, everything returned to the pre-pandemic state. However, the pandemic prompted many destinations to re-evaluate their tourism management strategies and to prioritize sustainability, resilience and community engagement.

More generally, examples of such destinations included cities like Barcelona, Rome, Florence, Dubrovnik and Amsterdam, as well as coastal regions in Spain, Italy, Greece, and Croatia. These places struggled to balance the economic benefits of tourism with its negative impacts on local communities and the environment. However, with the onset of the COVID-19 pandemic and the subsequent travel restrictions and lockdowns, the focus of tourism underwent a significant shift. Many northern locations, including Stockholm, Hamburg, Bergen, Riga and Copenhagen, particularly those with outdoor and nature-based attractions, experienced increased interest from tourists seeking destinations perceived as safer and less crowded. As a consequence of climate change, tourists will be motivated to consider alternative seasons for their trips, including spring and autumn, and to seek out destinations with more temperate climates.

In summary, the main contribution of this paper was to create a new composite indicator of the extent of overtourism by using optimization (cross-entropy-based rank aggregation), and an objective ranking of 28 European locations declared to be affected by overtourism. The selected settlements were mostly urban and therefore more homogeneous, allowing authors to make accurate comparisons. Given the availability of additional time series, it would be possible to track relative changes over time. The applied methods could also shed light on indicators that are more relevant to overtourism. These were the number of nights spent in paid accommodation per population, the number of overnight visits per

population and the number of air passengers. Tourism density and tourism intensity have a greater influence than other variables, in simplified terms. The results of the randomization test indicated that MMOORA performed the best among the three applied MCDM methods in terms of rank aggregation.

6.2 Limitations and future research

A number of important limitations must be considered. The study focused on the settlements for which relevant data were available for the years under consideration, between 2014 and 2023. As a result, smaller settlements, rural destinations and individual attractions were excluded from the research. In addition, the data did not include day visitors who did not stay overnight at the destination, nor tourists who booked accommodation in surrounding towns or villages, or cruise ship passengers, who contribute to the daytime crowd but do not generate significant tourism revenues for the host area. Moreover, the scope of this study was also limited in terms of available data, as an examination of more time periods would have provided even more adequate results. In particular, short-stay accommodation data was only available between 2018 and 2023, and for only 24 out of the 28 locations studied. In addition, dynamic changes in weather data before and after the COVID-19 crisis were not associated with corresponding changes in overtourism rankings. The current research was not specifically designed to evaluate factors related to subjective perceptions of dissatisfaction or perceived negative aspects by the local population. In addition, the proposed rank aggregation procedure included only three decision methods (VIKOR, TOPSIS and MMOORA).

The authors of the study recognized the need for future research to examine a wider range of indicators, including data from more municipalities, to cover not only the period 2014–2023, and to analyze both annual and monthly data, due to seasonality, especially for weather conditions. It would also be desirable to extend the current research to locations outside the European region.

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Further reading

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