SMART SOLUTIONS FOR SUSTAINABLE TOURISM PEARLS: HOW TO LIVE BETWEEN CULTURE AND TOURISM IN DUBROVNIK

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ABSTRACT

Dubrovnik is one of the most visited destinations on the Adriatic coast. However, the large number of visits is affecting the heritage area of the city, and since the Old City of Dubrovnik have been under the UNESCO protection from 1979 it is important to achieve the balance between tourism and sustainability of the heritage site. The use of smart and open data can improve tourism flow management in cultural heritage sites.

The aim of this article is to identify innovative solutions, with the support of new technologies and big data, in order to reduce negative impacts of tourism on cultural heritage sites. The set of indicators are defined and a holistic model is proposed to analyse these data and use them in sustainable management of cultural heritage cities. The newly developed smart holistic models are presented in the case of the City of Dubrovnik since it is largely dedicated to tourism. The analysis of tourist flows in the City of Dubrovnik has been done following a system of indicators developed by the Agency for sustainable Mediterranean cities and territories in the framework of Interreg Mediterranean project HERIT-DATA that consists of 21 indicators divided into 6 groups. A large number of tourists are affecting not only space and infrastructure, but also the life of residents. Therefore, it is of the greatest importance to manage tourism in a more holistic and sustainable way and to find the balance between tourism and its economic contributions and sustainability.

The proposed set of indicators and a new smart holistic model will help policy makers, destination managers, cities and sites to anticipate and manage the tourism flows in a smarter way. The results of the analysis showed that the overtourism in Dubrovnik has still not affected the infrastructure and environmental conditions, but it greatly affects the residents of the city and their quality of life. Also, the smart solution for managing the tourism flows in the Old City of Dubrovnik already exists, in the form of Application for the prediction of the number of visitors, but it should be used in a way that helps better manage the tourist flows.

KEY WORDS

CLASSIFICATION

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INTRODUCTION

Dubrovnik, also known as the "pearl of the Adriatic" is one of the most visited destinations on the Adriatic coast. In 2021, it was the third most visited Croatian city with the total of 518 000 tourist arrivals. However, as large number of visits is affecting the heritage area of the city, and since the Old City has been under the UNESCO protection since 1979, it is important to achieve balance between tourism and sustainability of the heritage site. In order to do so, first steps have been taken when UNESCO recommended the maximum number of 8000 tourists daily. But, the City of Dubrovnik is still facing the problem of overtourism, which is defined as "the excessive growth of visitors leading to overcrowding in areas where residents suffer the consequences of temporary and seasonal tourism peaks, which have caused permanent changes to their lifestyles, denied access to amenities and damaged their general well-being" [1].

The aim of this article is to identify innovative solutions, with the support of new technologies and big data, in order to reduce negative impacts of tourism on cultural heritage sites. In order to deal with the problem of overtourism, first it is necessary to analyse management of tourism flows to observe the sustainability of different heritage sites under the pressure of tourism. The set of indicators has been developed with aim to analyse data on the tourism flows and to use them in sustainable management of cultural heritage cities. These indicators analyse not only the tourist overcrowding, but also environmental and economic conditions, perception of overcrowded places, quality of services and residential quality of life, since the overtourism affects not only space and infrastructure, but also the life of residents. To avoid the negative effects of overtourism, it is of the greatest importance to manage tourism in a sustainable way and to find balance between tourism and its economic contributions, and sustainability. A way to improve the tourism flow management is the use of smart and open data. This article tries to answer the question whether the smart solutions introduced in the Old City of Dubrovnik, i.e. the cameras that count the number of people in the historic centre, affect the number of visitors, and if not, what other digital solutions can help dealing with overtourism in Dubrovnik.

PREVIOUS RESEARCH

In the past forty years, the tourism has grown rapidly, mainly due to increased demand for mobility, leisure and unique experiences. The consequences of the tourism growth are pressures not only to cultural and natural heritage, but also pressure on life of residents. Debates concerning the pressure from tourism activity and dependence on tourism sector have helped tourism practitioners to shape policies and plan interventions. However, in most cases, policies and interventions were made to help solving problems associated with tourism, rather than addressing the underlying root causes to reach a long-term solution. Over time new terms "overtourism" and "tourismphobia" have emerged to describe rapid unfolding of unsustainable mass tourism practices and the responses that these have generated amongst academics, practitioners and social movements concerned with the use of urban, rural and coastal spaces for tourism purposes in a damaging and harmful manner [1]. According to Milano, Cheer and Novelli the term overtourism implies loss of sense of belonging, diminishment of sense of place, increased congestion and privatisation of public spaces, explosive growth of cruise tourism, rapid growth of tourism and day visitors, the rise in tourism induced real estate speculation and associated decline in power parity of local residents compared to visitors, dismantling of socio-cultural connectivity and the mainstream of special niche tourism practices in vulnerable places such as national parks, small islands and critical cultural heritage places [2].

Overtourism can have an impact in multiple ways – it is harming the landscape, damaging beaches, putting infrastructure under strain and pricing residents out of property market. One of the examples is the cruise industry that delivers thousands of passengers daily, while little is returned to

communities. Impact of overtourism on local residents is huge – cities transform to cater for tourists, while property speculations and costs of living for local communities increase. However, there are several measures to limit the effects of overtourism some cities have taken, such as revised taxation arrangements, fines linked to new local laws, and "demarketing" – focusing of the destination on attracting fewer, high-spending and low impact tourists, rather than large groups [3].

Overtourism causes tourismphobia, which is defined as "a feeling of rejection towards tourism that manifests in the form of assaults to restaurants, businesses and yachts; attacks on tourist buses, bikes damaged in tourist spots, and other acts of vandalism" [4]. According to Veríssimo, Breda, Guizi and Costa most of those host-tourist conflicts arise when host communities feel some economic impacts, such as loss of purchasing power, rising prices, overvaluation of rents, as well as those of a social and cultural nature, namely increasing poverty, loss of local cultural identity, gentrification and the feeling of urban alienation, noise and tourist incivility, and other issues [5].

In order to solve overtourism-related problems, it is necessary to determine its degree and ensure its effective measurement and monitoring, which is essential for effective tourism management. Overtourism monitoring has also been a topic of several research studies. For example, Khomsi, Fernendez-Aubin and Rabier analysed overtourism in Monteral using the number of tourists in comparison with the number of inhabitants, tourism carrying capacity and tourism pressure as core indicators [6]. The results of their research showed that deseasoning deludes negative perception of tourism since the problems such as road congestion is not therefore felt throughout the year. Also, the degree of negative views on tourism remains localized in only one area and perception of overtourism is subjective. Due to the stated factors, the authors of the study concluded that Montreal does not suffer from overtourism as do other famous destinations like Venice and Dubrovnik.

The study of Pikkemaat, Bichler and Peters is focused on skiing as a tourism activity and estimates satisfaction of tourists in ski resorts in Austria [7]. Authors show that certain demographic factors, such as age, have an impact on perceived crowding and satisfaction. The authors also highlight the importance of tourist-to-tourist encounters to gain a better understanding of crowding effects and to propose appropriate visitor management measures.

Cakar and Uzut analysed the case study of Istanbul to investigate the role of sustainable degrowth as a strategy to deal with overtourism [8]. Authors found that demarketing and applying localhood tourism activities are key drivers behind the degrowth response. Degrowth solution required sustainable destination governance, prudent management and stakeholder involvement.

Camatti, Bertocchi, Carić and van der Borg proposed a tourism carrying capacity (TCC) calculation model and applied it to the case of Dubrovnik [9]. This real-time response helps monitor overtourism in Dubrovnik using the support of current mobile technology. The study suggests the ways in which a heritage tourism destination can determine the sustainable limit of tourists and visitors to different types by considering the maximum capacities of various subsystems including accommodation sector, food and beverage sector, mobility and transportation facilities, environmental issues and waste management, and cultural site. The model enables the authors to stimulate the maximum number of visitors and the composition of visitors. It enables researchers to estimate potential revenues and provides real-time intervention to mitigate potential overtourism, facilitate decongestion policies and promote destination sustainability.

The use of technology and big data in tourism is also analysed by Wang, Ban and Kim who showed that big data analyses can create social and environmental values and financial and economic sustainability [10]. The tourism sector must adopt new competitive strategies and enhance organizational dynamism by incorporating big data analytics and business models into their operations. According to authors, the influence of big data on the creation of social value

in tourism sector is based on creating employee value through encouraging development of good working conditions, improving employee capacity, improvement of work-life balance and happiness, and fostering a harmonious work environment.

Finally, Hawkins, Chang and Warnes who compared experts' and stakeholders' ratings of 33 World Heritage destinations, state that local stakeholders need to be recognized for their essential role on tourism planning and development [11]. The research showed that local stakeholders and experts have similar views on the sustainability of the World Heritage destinations. In some cases, experts did state problems that were not mentioned by stakeholders that were about safety concerns and environmental issues, especially concerning trash and litter. In the rest of the cases, stakeholders' comments echoed experts' views. The most concerning problems are environmental concerns, loss of cultural integrity and damage to the built heritage. According to experts, high involvement of government sectors in management of tourism sites through means of financial support and enforcement of regulations result in higher level of sustainability of the tourist destination and sites.

METHODOLOGY

The analysis of tourist flows in the City of Dubrovnik has been done following a system of indicators developed by the Agency for sustainable Mediterranean cities and territories in the framework of Interreg Mediterranean project HERIT-DATA. The system of indicators is defined as a set of information that observes the sustainability of different heritage sites under the pressure of tourism. The developed set of indicators consists of 21 indicators divided into 6 groups. However, in this article indicators have been adapted to the tourism in the City of Dubrovnik.

The set of indicators analysed in this article also consists of 6 groups. First group of indicators analyses basic characteristics of tourism in the City of Dubrovnik. The second group of indicators analyses cultural heritage preservation level of – the Old City. Third group of indicators is dedicated to tourist flows in the Old City, while fourth group deals with the perception of local residents and tourists. Fifth group of indicators analyses quality of services and security in the City of Dubrovnik and the last, sixth, group analyses the quality of residents' life.

The list of indicators analysed in this article have been presented in Table 1.

Methods used in the analysis of the tourist flows include desk research, big data, comparative analysis and deduction. Several sources of information have been used in analysis of the tourist flows, including tourist agencies in Dubrovnik for the recognition of areas and sites of tourist values, Institute for tourism research for the identification of tourism profiles, Dubrovnik Port Authority database for the number of cruise ships and passengers, Croatian Chamber of Commerce database for indicators related to companies and employment. Additionally, the City of Dubrovnik Tourist Board provided data related to the number of arrivals and number of overnight stays, while the Croatian Bureau of Statistics database was used for analysis of the accommodation facilities. For the analysis of capacity and quality of services provided, the Waste management service in Dubrovnik, Dubrovnik Police Department, the public transport company and public parking spaces management company have been contacted. Additionally, databases provided by the Ministry of Economy and Sustainable Development of the Republic of Croatia have been used in the analysis of air pollution and databases provided by the Ministry of Finance of the Republic of Croatia have been used in the analysis of prices of houses and apartments in Dubrovnik. The Dubrovnik Development Agency (DURA) provided the data collected by way of cameras in the historic centre that count the number of visitors. Finally, for the analysis of personal perception, i.e. the social net analysis, the Social searcher platform was used, which uses key word Twitter, Facebook, Vkontakte, YouTube, Flickr, Instagram, Reddit and Dailymotion. Also, for s to search through 11 sources, including Web, Tumblr, Vimeo, the

Table 1. List of indicators.

Group of indicators	Indicators
Characterisation of areas of heritage value	Characterisation areas/sites of tourist value and tourism profiles
	Access capacity charge (heritage area from port)
	Capacity charge of the heritage area
Site capacity overcrowded	Preservation level in optimal conditions (environmental and architectural) of sites of cultural value
Tourist city flows	Optimal levels of overcrowding of people transit
	Optimal levels of tourists overnight
Perception of overcrowded places	Tourists perception about adequacy of overcrowded site experience
	Residents perception about adequacy of overcrowded site experience
	Personal perception about adequacy of security site experience
	Personal perception about hygiene, sanitation and cleaning conditions site experience
	Personal perception about cultural heritage preservation site experience
Capacity and quality of services access (heritage area)	Optimal capacity of the urban cleaning service and décor
	Capacity to maintain optimal citizen security
	Capacity to ensure permitted ranges of contamination – basic environmental conditions in heritage areas
	Fluid access to public transport in heritage areas
	Fluid access to parking spaces around heritage areas
Residential quality site	Optimal levels of access to housing in tourist areas by local population
	Optimal levels of access to employment quality in tourist areas by local population
	Optimal levels of access to local stores and products in tourist areas by residential population
	Higher prices in target areas
	Lack of identity of the traditional activities within the UNESCO area

comparison of costs of living in Dubrovnik with other cities, the NUMBEO platform was used, which is the world's largest cost of living database.

DISCUSSION/RESULTS

As mentioned above, the developed indicator system is divided into 6 indicator groups. First indicator group – Characterisation of areas of heritage value describes the Old City of Dubrovnik – the areas of tourist value, tourist profiles, cruise tourism and capacities of the heritage area. Second group of indicators – Site Capacity Overcrowded analyses the preservation level of heritage site, optimal level of number of tourists at the site and optimal level of tourist overnight stays. Indicator group Tourist City Flows analyses the number of

people at the heritage site, while the group People perception of overcrowded places analyses both residents' and tourists' perception of overcrowdedness, security, hygiene, cleanliness, etc. Group of indicators Capacity and quality to services access (heritage area) analyses urban cleaning services, security, environmental conditions and public and private transport. Finally, the last group, Residential quality site, consists of indicators that analyse access to housing, employment quality and costs of living in the heritage area.

CHARACTERISATION OF AREAS OF HERITAGE VALUE

The first group of indicators gives the basic information of the heritage site – the Old City of Dubrovnik. According to the data and the records kept by the Ministry of Culture and Media of the Republic of Croatia Directorate for the Protection of Cultural Heritage and the Conservation Department in Dubrovnik, there is a total of 535 immovable cultural assets under protection and under preventive protection in the Region, 486 of which are protected and 49 are under preventive protection. According to the data provided by the Conservation Department in Dubrovnik and the Physical Planning Institute of the Dubrovnik-Neretva County, there are 1968 registered cultural assets in the Region's area. The total number of immovable cultural assets that are under regular and preventive protection and registered in the Dubrovnik-Neretva County is 2503.

The main tourist attractions in the City of Dubrovnik and its hinterland are the Dubrovnik City Walls, Fort Lovrijenac, The Franciscan Church and Monastery, Stradun, Cavtat Cemetery, Minčeta Fortress, Church of St. Ignatius of Loyola, Church of Saint Blaise, Dominican Monastery, St. John's Fortress, Fort Bokar, Synagogue, Cathedral Treasury, Brsalje Street, and the Ston Old Town.

Tourist profile in the City of Dubrovnik was analysed by Marušić, Horak and Čorak in the framework of TOMAS research [12]. According to this study, the average age of Dubrovnik guests is 42 years. Half of the guests in 2018 (51 %) were between 30 and 49 years old. Slightly older guests (45 years on average) come from the UK and Italy, while the younger guests come from Spain (39 years), Ireland (40 years) and Scandinavian countries (40 years). Guests in hotels, as more solvent guests, were older than guests in family accommodation (46 years in hotels vs 38 years in family accommodation). Slightly less than two thirds of guests who visited Dubrovnik were accompanied by a partner (63 %), while a fifth of them come accompanied by other family members. While family arrival is the most common among Italians (24 %), arrival with a partner was above average for guests from the UK (78 %), France (78 %) and Ireland (76 %). In hotels, guests from the USA came with their families more often than the average (32 %).

Economic contribution of tourism to an area is mostly analysed by tourist consumption. According to the TOMAS research, the average daily tourist consumption in 2018 in Dubrovnik was EUR 170 per day [12]. The largest share of this consumption was spent on accommodation (51 %), on food and beverage in restaurants and bars (25 %), which was followed by expenditures on culture and entertainment (8 %), purchase (7 %) and expenditures for local transport (6 %). During their stay in Dubrovnik, visitors from ships on international cruises spend an average of EUR 51 (EUR 59 spent by passengers and EUR 26 spent by the crew). Most of it, over a half of the total consumption, is spent on food and beverage in catering establishments (32 %) and on purchases (26 %). In Dubrovnik, crew members spend almost 90 % of their average consumption on food and beverage as well as on shopping.

Dubrovnik is also a world-famous port with a huge number of disembarkations. According to the data of the Dubrovnik Port Authority, the total number of cruise ships in Dubrovnik in 2019 was 486 and the total number of passengers was 768 924, which represents the increase of 5 % compared to 2018 (732 431 passengers) and the increase of 8 % compared to 2017 (709 517 passengers). The total number of cruisers in 2019 increased for 11 % compared to 2018 (438 cruisers) and for 10 % compared to 2017 (443 cruisers).

On a monthly basis, the largest number of cruise ships arriving is between May and October, with the peak in October 2019 and in August 2018. In 2020, due to the COVID-19 pandemic, the total number of cruise ships was 47, which is way less than in the usual peak months. Cruising tourism has recovered a little bit in 2021 and 2022, but it is not yet on pre-pandemic levels. The number of disembarkations on monthly basis is presented in Figure 1.
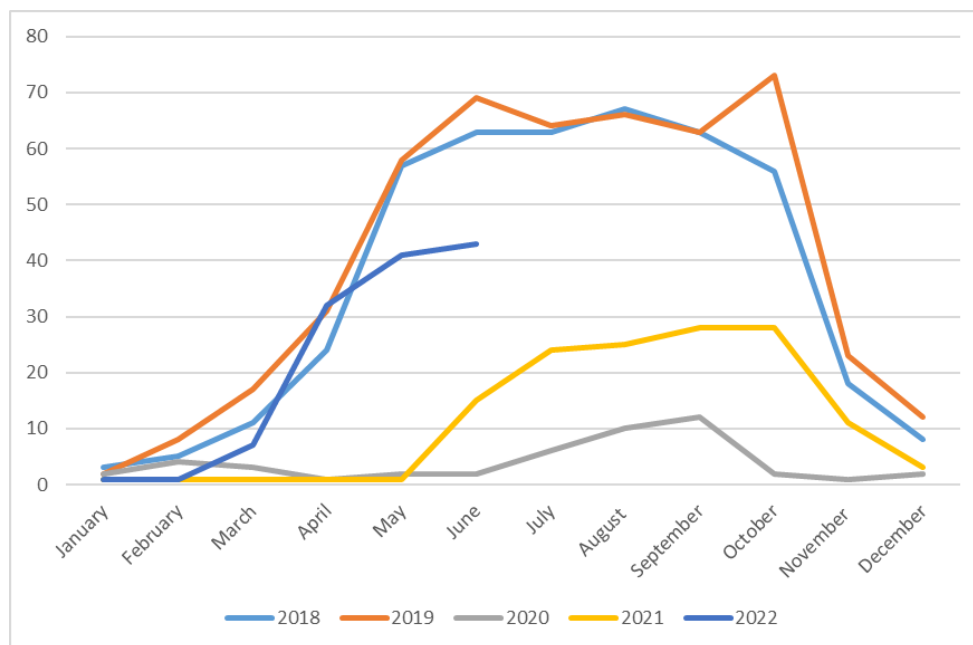

Figure 1. Number of cruise ships by months (Dubrovnik Port Authority).

Finally, the indicator Capacity charge heritage area analyses capacities of the area in the field of saturation sites, accommodation and restoration. Capacity of saturation sites analyses permitted capacity of historic centres, heritage area and cultural heritage business. According to the UNESCO recommendation, the maximum number of tourists allowed in the Old City of Dubrovnik is 8000 per day and according to travel agencies, the recommended duration of the visit to the Old City of Dubrovnik is 6 hours.

The total number of accommodation facilities in the Old City of Dubrovnik is 34 – 2 hotels, 1 Bed and Breakfast (B&B), 2 hostels and 29 private accommodation facilities. The total number of rooms and suites in hotels is 27 and in hostels 18 rooms. The number of rooms in B&B is not available. The total number of apartments and rooms in private accommodation facilities in the Old City of Dubrovnik is 137.

The total number of companies engaged in tourism in Dubrovnik is 636, out of which 206 in the Accommodation sector, 266 in Food and beverage service activities and 164 in Travel agency, tour operator and other reservation services and related activities. Also, there are 6 Official tourism information centres in the heritage area of Dubrovnik.

Since official data on the number of restaurants and bars is not available, the analysis was carried out by Google Maps research. The analysis showed that there are 63 restaurants in the Old City of Dubrovnik, 6 fast food restaurants and 3 ice cream shops. The number of bars in the Old City of Dubrovnik is 22.

SITE CAPACITY OVERCROWDED

The Old City of Dubrovnik as a heritage site is characterised as uncovered outdoor space, therefore the meteorological conditions are pretty important for its preservation. The average temperature in the period 1961-2020 in Dubrovnik was 16,7°C. The coldest month in

Dubrovnik was January with approximately 9,1°C and the warmest was August with 25,3°C. The average environmental parameters for 2022 in Dubrovnik are temperature 24,9°C, relative humidity 47 %, air pressure 1019,0 hPa and wind NNE 4,4 m/s. These environmental parameters can be described as optimal for the heritage preservation.

Materials used in the heritage site construction – the Old City of Dubrovnik are prescribed by the UNESCO World Heritage Management Plan "Old City of Dubrovnik" and they include traditional building materials, i.e. stone instead of wood. According to the Law on Protection and Preservation of Cultural Heritage, the interventions that can be performed in the area are only those which are in accordance with the conclusions of conservation documentation relating to the repair of the structure, roof reconstruction, replacement of old joinery and using only traditional materials and construction details designed in the traditional way.

TOURIST CITY FLOWS

Detection real transit of number of people/area/time analyses displacements in historic centres of the cities in order to determine if high concentrations are taking place in certain transit routes, which hinder a normal flow of people.

The source of data for the indicator component are cameras placed at the critical points in the City of Dubrovnik. The data presented are for the time period from May 1 until October 31 in 2019 and 2020, and from May 1 until September 4, 2021. The total number counted in 2019 was 1147 233; in 2020 it was 502 175, and in 2021 it was 582 099. The number of daily visitors is shown in Figure 2. The figure shows that the largest number of people at critical points in Dubrovnik was in August 2019. In 2020, the number of people was much lower than the average due to the COVID-19 pandemic, but the numbers in 2021 show that tourism in Dubrovnik was not as affected by the pandemic as in 2021 – in some periods in August and September the number of visitors was the same as in the best tourist year, 2019.

The threshold for the indicator Detection real transit of number of people/area/time is still not defined, but considering that UNESCO recommended the maximum number of 8000 tourists daily, that threshold was achieved in both 2020 and 2021, when maximum number of daily visitors was 6055 in 2020 and 7986 in 2021. On the other hand, the maximum number of 10 240 tourists in 2019, surpassed the recommended number. The total number of days when the number of tourists surpassed the recommended number was 47.
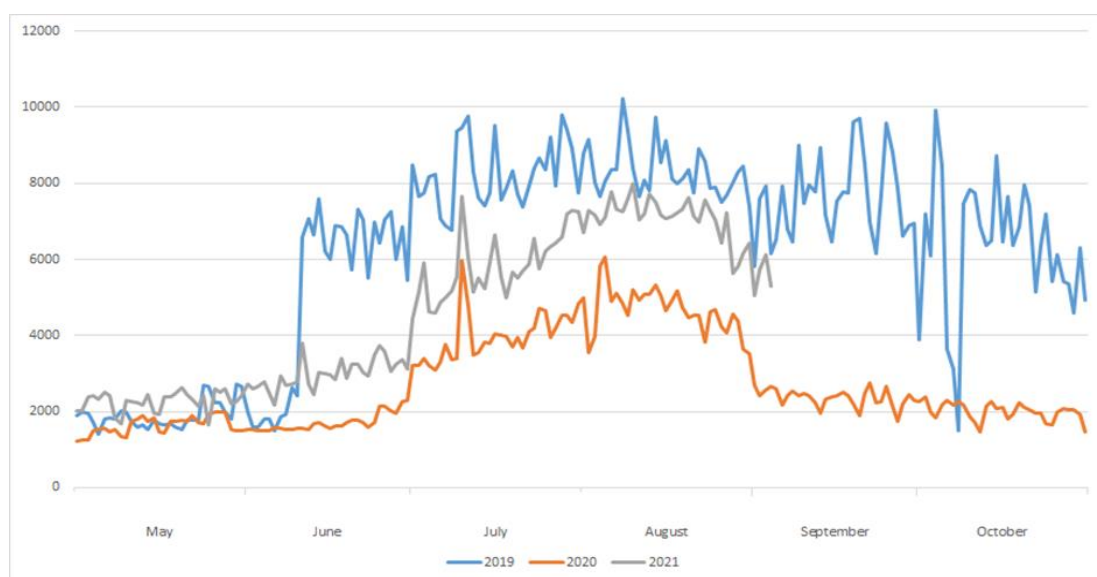

Figure 2. Number of visitors at the critical points in Dubrovnik (DURA City of Dubrovnik Development Agency).

Indicator Detection real transit of number of people/area/times also analyses the predicted number of tourists in areas where excessive crowding of people on transit routes can occur based on the information on tourist tour reservations and their route as well as to propose alternative routes. The indicator is measured through Application for predicting the number of visitors, which uses machine learning (the branch of artificial intelligence) to predict the number of people in the Old City of Dubrovnik on a given day. This data can be useful to both citizens and tourists to support optimal planning of their visits to the Old City of Dubrovnik. To predict the number, the machine learning algorithm uses various parameters such as the number of people coming from cruise ships, number of tourist arrivals and overnight stays as well as weather data such as temperature and precipitation.

The Application shows the predictions until the end of 2022 and predicts that in the following period, the Old City of Dubrovnik will be crowded for 4 days and slightly crowded for 15 days while the rest of the period there will be no crowd in the historic centre.

Saturation of accommodation facilities analyses the number of beds in official and un-official accommodation facilities, as well as the number of overnight stays in official and un-official accommodation facilities. Also, the component analyses the ratio between the number of tourists overnight stays and the number of residents. Total number of overnight stays in the City of Dubrovnik was constantly increasing until 2020, when the COVID-19 pandemic affected the world tourism. However, the data show that in 2021 the tourism sector has started to recover – the number of overnight stays was almost twice larger than in the whole 2020.

The most of the overnight stays were in official accommodation including hotels, villas, camps, etc. However, the share of overnight stays in official accommodation slightly declined when compared to the pre-pandemic period. In the period 2016-2019, the share of overnight stays in official accommodation within the total accommodation was around 65 %-70 %, while in 2020 and 2021 it was between 50 % and 55 %.

Saturation ratio of official and un-official accommodation are analysed on the yearly basis since there are no available data on the number of overnight stays by accommodation facilities, which is a reason why values of the saturation ratio are way smaller than expected. However, average annual data show that official accommodation facilities in Dubrovnik are more occupied than the un-official.

According to the Agency for sustainable Mediterranean cities and territories, threshold value for the Saturation of accommodation facilities is 93 % and it was achieved during the whole period of the analysis. The largest value of saturation of accommodation facilities was achieved in August 2016 and it was 88,07 %, which is presented in Figure 3.
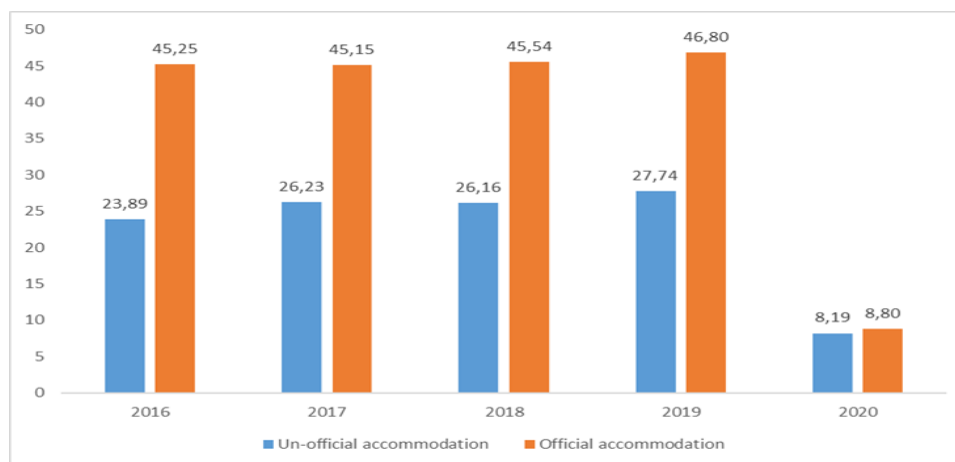

Figure 3. Saturation ratio of official and un-official accommodation facilities (City of Dubrovnik Tourist Board).

PEOPLE PERCEPTION OF OVERCROWDED PLACES

People perception of overcrowded places, brings together main elements of the tourist experience perception (both those generated by the tourist and of the population resident in the area), as a key qualitative component when diagnosing the behaviour of the system in relation to its greater or lesser saturation. It consists of five indicators: Tourist perception about adequacy of Overcrowded site experience, Residents perception of adequacy of Overcrowded site experience, Personal perception about adequacy of Security site experience, Personal perception about hygiene, sanitation and cleaning conditions site experience, and Personal perception about cultural heritage preservation site experience. All of the indicators are measured in real time as a social net perception and post-experience.

The social net analysis of the perception about Overcrowded site experience has been done using the Social searcher platform [13], using the key words Dubrovnik, crowd and overcrowded. The application searched through 11 sources including Web, Tumblr, Vimeo, Twitter, Facebook, Vkontakte, YouTube, Flickr, Instagram, Reddit and Dailymotion. The results of the analysis are shown for the period from April 5, 2013, to September 4, 2022. The total number of posts in that period was 465, out of which 141 were positive, 273 were neutral and 51 were negative.

The source of data for the Overcrowded site post-experience is the TOMAS research conducted in Dubrovnik in 2018 by the Institute for Tourism [12]. The research showed that overcrowding was the main element negatively affecting tourists staying in Dubrovnik. Most of the visitors are unsatisfied with crowds in public areas and presence of cruise passengers, followed by traffic jams, crowds on the beaches and presence of cruise ships.

The social net analysis of the residents' perception about Overcrowded site experience was carried out via the Social searcher platform, using the key words Dubrovnik, crowd and overcrowded while setting of the language was Croatian. The results of the analysis are shown for the period from January 19, 2008, to September 4, 2022. The total number of posts in that period was 304, out of which 19 were positive, 257 were neutral and 28 were negative.

The social net analysis of the perception about security was carried out via the Social searcher platform, using the key words Dubrovnik and security. The results of the analysis are shown for the period from November 30, 2005, to September 4, 2022. The total number of posts in that period was 283, out of which 93 were positive, 167 were neutral and 23 were negative.

Index perception post-experience Security analyses tourists and residents' perception of the environment security. According to the Institute for Tourism's TOMAS research, personal security is the second-best tourism supply element and it was rated as very satisfying with 92 % of visitors saying they were satisfied with personal security during their stay in Dubrovnik.

The social net analysis of the residents' perception about overcrowded site experience was carried out via the Social searcher platform, using the key words Dubrovnik, hygiene, sanitation, cleaning and garbage. The results of the analysis are shown for the period from April 5, 2013, to September 4, 2022. The total number of posts in that period was 100, out of which 33 were positive, 50 were neutral and 17 were negative.

Index perception post-experience about hygiene, sanitation and cleaning conditions also analyses the satisfaction of tourists and residents with cleanliness and hygiene of heritage spaces in order to see whether any adjustments should be made in the resources dedicated to maintaining the cleanliness and hygiene. According to the TOMAS research, perception about hygiene, sanitation and cleaning conditions is both, positive and negative. The research showed that tourists were very satisfied with tidiness of the place, ecological preservation and clean beaches. On the other hand, improperly disposed garbage, unpleasant odours and impossibility of waste separation negatively affected tourist stay.

Index perception post-experience cultural heritage preservation answers the question whether the conservation of the heritage space meets tourists' expectations. The data source for the indicator component is again TOMAS research, which showed that degree of satisfaction with cultural heritage preservation was high, with 77 % of visitors saying that they were satisfied with the richness of the cultural heritage.

CAPACITY AND QUALITY TO SERVICES ACCESS (HERITAGE AREA)

Capacity and quality to services access (heritage area), encompasses a measure of the degree of adequacy of access to strategic public services in the area: cleanliness, security, pollution, public transport and parking.

According to the data of Čistoća Dubrovnik (utility company in charge for cleanliness maintenance and waste management), the number of garbage bins in the Old City of Dubrovnik is 56, while the number of smart containers for small waste is 14 pieces, which gives the total of 70. When compared to the average number of people counted in the Old City of Dubrovnik in 2021, which is 4583 persons, it gives the value of 15,27 garbage bins per 1000 people. In the Old City, mixed waste containers are set up daily at night between 8 pm and 10 pm. They are emptied and removed from the streets in the morning between 5 and 7 o'clock. The total number of containers is 30 pieces of 240 litres. Together with the containers, the total number of bins in the Dubrovnik Old City is 100, which is 21,2 bins per 1000 people.

The total number of garbage bins in the City of Dubrovnik is 161, which together with 81 pieces of smart containers gives the total of 242. According to the assessment of the Croatian Bureau of Statistics, there is 44 743 inhabitants in the City of Dubrovnik, which means that the number of garbage bins per 1000 inhabitants is 5,41. In the City of Dubrovnik, the total number of containers is 931, out of which there are 572 containers for mixed municipal waste, 141 paper containers, 145 containers for packaging plastics, 65 packaging glass containers and 8 metal containers. When compared to the number of inhabitants, there are 20,81 containers per 1000 inhabitants. The total number of bins in the City of Dubrovnik is 1173, which means that the number of bins is 26,22 per 1000 inhabitants.

The threshold value set by the Agency for sustainable Mediterranean cities and territories for ratio people/baskets/containers is 31,2 litter bins per 1000 inhabitants, which means that the threshold is not achieved.

According to the data provided by Čistoća Dubrovnik, the average amount of waste varies from month to month. The biggest amount of waste is collected during July and August amounting to 8 tons per day. In April, May, June, September and October, the average daily amount of collected mixed waste is 6 tons, while in November, December, January, February and March, the average collected mixed municipal waste amounts to 3 tons per day.

The threshold value for volume of solid waste collection is annual average, with the toleration of 10 % exceeding. The annual average of solid waste collection is about 5 t/day, which means that most of the year, in the period from April until October, the threshold value is not achieved.

Mixed municipal waste containers are emptied daily in the morning. Small waste bins are emptied constantly during the day from 5 am to 12 pm. Streets and open gardens in the Old City of Dubrovnik are cleaned constantly during the day from 5 am to 12 pm. Intervention ratio hygiene service by area has a threshold once a day, which is achieved.

Crime rate in target area answers the question whether there is capacity to maintain optimal conditions of citizen security in heritage zones. The main aim of the component is to find out to what extent the perception of security during tourist visits is a factor that should be considered when managing mass tourism in cultural heritage areas.

The total number of criminal offences in the City of Dubrovnik was 1172 in 2016, 1316 in 2017 and 1285 in 2018. In the analysed period, the largest crime rate per 1000 inhabitants was in 2017 – 29,81. The number of robberies with violence or intimidation in 2016 was 105. The number of criminal offences and misdemeanours of all types of theft was also largest in 2016 – 107, Table 2.

Table 2. Crime rate in the City of Dubrovnik (Dubrovnik Police Department. Overview of basic safety indicators 2018/2017 and 2017/2016.

	2016	**2017**	**2018**
Criminal offences	1172	1316	1285
Inhabitants	43 950	44 149	44 376
Crime rate per 1 000 inhabitants: (total known criminal offences/total population) x 1 000	26,67	29,81	28,96
Number of robberies with violence or intimidation	105	79	84
Number of criminal offences and misdemeanours of all types of theft	107	82	88

Threshold value set by the Agency for sustainable Mediterranean cities and territories is less than 45,2, which means that in Dubrovnik the threshold value is achieved.

Air pollution ranges in heritage environmental stations answers the question whether there is capacity to maintain adequate air quality conditions in heritage areas. The objective of the component is to assess the situation and dimensions of the pollution problems in the monitoring areas.

There are two air pollution measuring stations in the City of Dubrovnik – Žarkovica and the Dubrovnik Airport, both of which are situated out of the cultural heritage area. According to the Ministry of Economy and Sustainable Development of the Republic of Croatia database "Air quality in the Republic of Croatia", the data for Žarkovica station are not available.

As regards the Dubrovnik Airport measuring station, the data for five pollutants – NO_2, O_3, SO_2, PM10 and PM2.5 are shown in Table 3. The table shows the maximum value of each pollutant in September 2021. Hourly concentration values were used in case of NO_2, O_3 and SO_2, while in case of PM10 and PM2.5 pollutants daily concentration values were used.

Table 3. Air quality in the Republic of Croatia (The Ministry of Economy and Sustainable Development of the Republic of Croatia database).

Pollutant	Emissions, µg/m3	Air quality
PM2,5	19,46	Good
PM10	25,296	Good
O3	166,68	Regular
NO2	15,037	Very good
SO2	40,976	Very good

Comparing the values of emissions with the ranges established for each pollutant, it can be concluded that air quality in Dubrovnik is good, since maximum emissions of PM2.5 and PM10 in the analysed period were good, emissions of NO_2 and SO_2 very good and emission of O_3 was regular.

Waiting times in main transport public analyses whether there is a capacity to maintain fluid access to public transport in heritage zones. According to the Libertas Dubrovnik Ltd. data, there is one bus stop situated near the Old City of Dubrovnik. It is covered by 8 bus lines. Buses run every 15-30 minutes on average on weekdays and Saturdays and every 15-35 minutes on Sundays. The average delay times on 5 out of 8 lines are negligible and there are no problems

with departures from the terminal as they are within a minute delay. Average delay time for two lines is slightly longer and is about 3 minutes, while for one line it is approximately 1 and a 1/2 minute.

Threshold value for the indicator component waiting times in main public transport is less than 10-15 minutes. Data for the average waiting times in public transport around the Old City is not available, but 8 lines go near the Old City whose average departure is every 15-30 minutes on weekdays and Saturdays and every 15-35 minutes on Sundays, which means that in the worst case, waiting time for bus will be 30 minutes on weekdays and Saturday and 35 minutes on Sundays. In this worst case, threshold value is not achieved.

Percentage of free parking spaces in parking areas around the UNESCO Centre analyses whether there is a capacity to maintain a fluid access to free parking spaces around the UNESCO Centre. Around the Old City of Dubrovnik (area from Ilijina Glavica to Boninovo) there are 744 parking spaces managed by the company Sanitat Dubrovnik. The average number of free parking spots around the Old City on weekdays until 4 pm is 0, and after 4 pm it is around 40 (5,37 %). On weekends, the average number of free parking spots is about 50 (6,72 %). These data refer to the period outside the tourist season. In the tourist season, it is almost impossible to find a free parking spot between 8 am and 10 pm. There are 711 additional parking spots in the Public Garage, but the number of free parking spots during the day is not available. The threshold value for the percentage of free parking spots in parking areas around the UNESCO Centre is over 5 %. That means that threshold values are achieved out of the season only during weekends and after work hours.

RESIDENTIAL QUALITY SITE

Residential/tourist housing ratio analyses the degree of touristification of the area, i.e. whether residents have access to housing in adequate conditions. Analysis of the way of living in the historic centre of Dubrovnik, the degree of touristification of the area is huge [14; p.135]. The data of the study showed that in the Old City of Dubrovnik, there are only 568 residential dwellings. On the other hand, the City of Dubrovnik Tourist Board unofficial data estimate that in 2019, there were 794 accommodation units in the Old City of Dubrovnik. That means that 58,3 % of dwellings in the Old City of Dubrovnik are dedicated to tourist rentals (tourist apartments).

Housing value (m2): rent/buy aims at collecting the data such as the price of housing and its annual variation, usually related to "gentrification", alluding to the process by which the original population of a sector or neighbourhood is progressively displaced by another with a higher purchasing power.

According to the data of the Ministry of Finance of the Republic of Croatia Tax Administration Office, the average price of apartments for sale in the City of Dubrovnik in 2021 was EUR 2775,49 per square meter, while the average price of houses for sale was EUR 686,15 per square meter. Prices of houses and apartments for sale in the City of Dubrovnik for the period 2016-2021 is shown in Figure 4. It shows a rapid increase in the prices of apartments per square meter and a slight decrease in the prices of houses per square meter in the analysed period.

The indicator Optimal levels of access to housing in tourist areas by local population also analyses whether tourism in the heritage area has a consequence of displacing part of the resident population towards other zones.

Based on the already mentioned Internal Census conducted in 2016, a demographic picture of the remaining inhabitants was outlined, an analysis of the main demographic indicators was made and the demographic collapse of the city population was presented according to specially processed census data from 1981, 1991, 2001 and 2011, conducted by the Croatian Bureau of Statistics. The results of the demographic study confirmed the total depopulation in the historic core of Dubrovnik
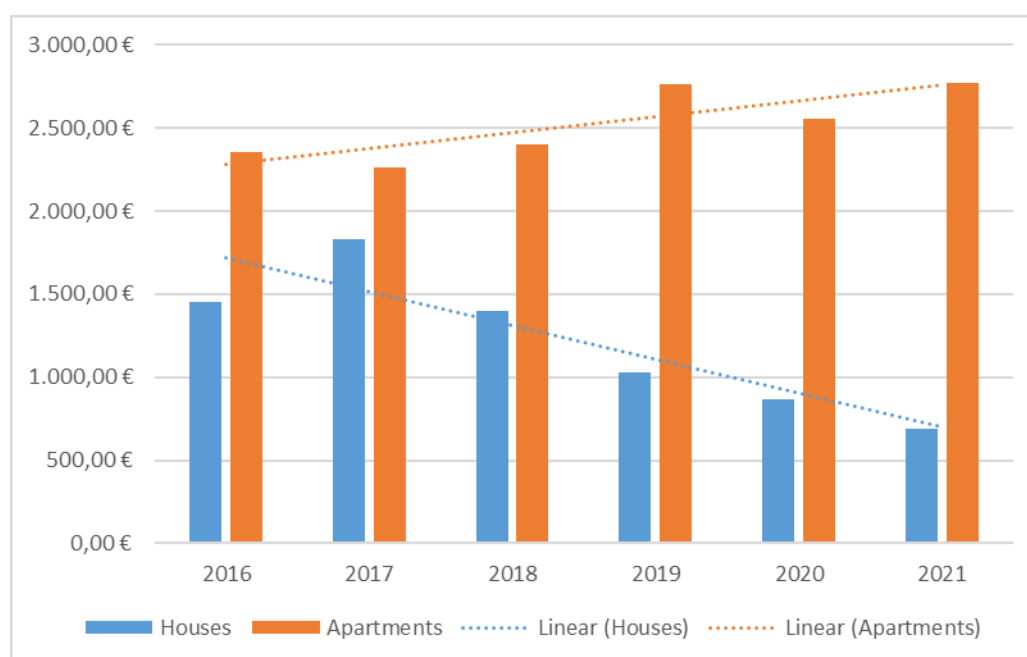
Figure 4. The prices of houses and apartments for sale per square meter (Tax Administration Office, Ministry of Finance of the Republic of Croatia).

today. In 2016, there were only 1557 inhabitants in 568 households, meaning that a quarter of that population was lost within a lapse of just five years (2011-2016). The urban image of the old city centre, which has never had fewer inhabitants before, has changed completely. The seriousness of the situation is indicated by the following data: from 1948 to 2016, the historic core of Dubrovnik lost about 65 % of its population, while in the last two inter-census periods (1991-2001, 2001-2011) it lost about 20 % of its population in every ten years period [14].

Rate and quality employment in target areas analyses whether the quality of employment in the tourism sector in the heritage areas is similar to other areas. In the City of Dubrovnik, tourism is the most important sector, which is also proved by the analysis of employment in Dubrovnik. Direct employment in tourism was calculated as the number of people employed in National Classification of Economic Activities sectors I – Accommodation and food service activities and N79 – Travel agency, tour operator reservation service and related activities. The total number of employed in those sectors was between 4631 in 2016 and 6290 in 2019. Compared to the total employment, direct employment in tourism in Dubrovnik is between 43 % and 48 % in the 2016-2021 period.

Compared to the direct employment in tourism within the total employment of the Dubrovnik-Neretva County, most of the direct employment in tourism of the County is in the City of Dubrovnik. However, it is important to keep in mind that this analysis only refers to companies. Crafts are being excluded since there are no available and comparable data at the city level.

Indicator Rate and quality employment in target areas should be compared to the region and cannot exceed it. The direct tourism employment in the total employment in Dubrovnik is between 43 % and 48 % in the five year-period, while the same ratio in the Dubrovnik-Neretva County is between 35 % and 39 %, which means that the threshold has not been achieved.

Analysis of the commercial offer in the target area answers the question whether residents have access to basic products in local shops. Since official data on the number of stores is not available, the analysis was carried out by Google Maps research. The analysis showed that in the Old City of Dubrovnik there are 38 shops – 5 retail shops, 2 bakeries, 3 pharmacies, seafood market, 1 convenience shop, 18 jewellery stores, 5 souvenir shops, 1 book store, 1 wine shop and 1 clothing shop.
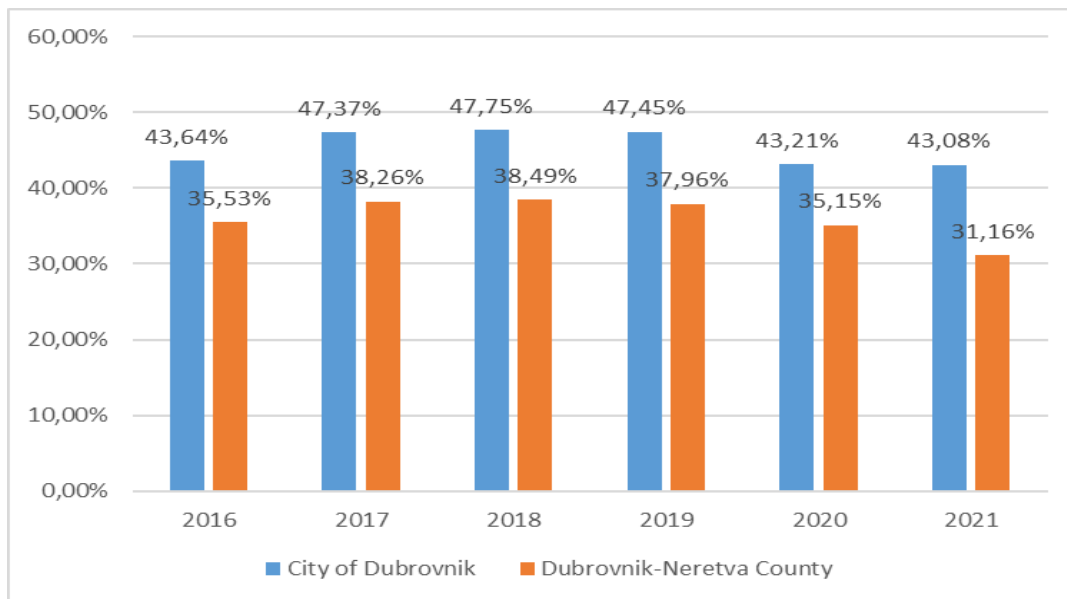
Figure 5. Direct employment in tourism within the total employment in the City of Dubrovnik and Dubrovnik-Neretva County (Croatian Chamber of Commerce, Digital Chamber).

Local price index analyses the degree to which life in the monitoring zones has become more or less costly.

Local price index for the City of Dubrovnik is not available. However, according to the data on NUMBEO the estimated monthly costs for a single person in Dubrovnik are EUR 727,34 without rent [15]. Compared to the other cities, Dubrovnik is 6,62 % more expensive than Zagreb (without rent). However, the rent in Dubrovnik is, on average, 14,14 % lower than in Zagreb.

Also, when monthly costs in Dubrovnik are compared with monthly costs in 8 Croatian cities (Zagreb, Slavonski Brod, Osijek, Sisak, Rijeka, Pula, Split and Varaždin) used for calculation of Consumer Price Index at the national level, Dubrovnik is also the most expensive city so it can be concluded that life in Dubrovnik is more expensive than in any other city in Croatia or in any other project pilot site.

Ratio between the number of tourists overnight stays and number of residents analyses the relevance of the number of tourist overnight stays compared to the local population in order to understand potential changes in social and economic aspects. Like indicators that analyse accommodation saturation, the indicator component ratio between number of tourist overnight stays and number of residents shows the largest values in August and July and the smallest in January. The largest value of the ratio was in August 2019, with 18,37 overnight stays per resident, while the smallest value of the ratio was in January 2016 with 0,58 overnight stays per resident.

Finally, the threshold value for the indicator component Ratio between the number of tourist overnights and number of residents must be smaller than one. In the case of Dubrovnik, the target is not achieved since average yearly ratio between the number of tourist overnight stays and number of residents ranged between 6,6 and 8,2 in the analysed period.

The threshold values for the indicators and whether they have been achieved in Dubrovnik are presented in Table 4.
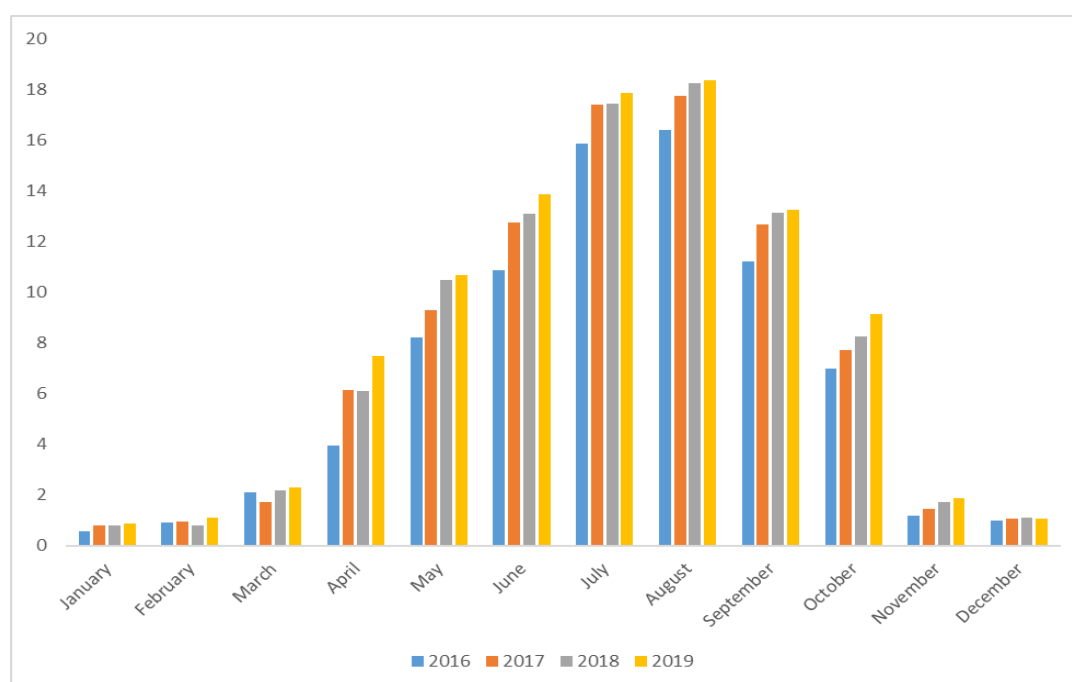
Figure 6. Ratio between the number of tourists overnight stays and number of residents (City of Dubrovnik Tourist Board, Croatian Bureau of Statistics).

Table 4. Achievement of threshold values in Dubrovnik (continued on pp.288-293).

Indicator	Indicator component	Value	Threshold	Achieved / Not achieved
Characterisation areas/sites of tourist value and tourism profiles	Delimitation and basic characteristics of sites subject to saturation: sites/spaces/heritage areas	535 immovable cultural assets under protection and under preventive protection 1968 registered cultural assets in the Region's area. The main tourist attractions in the City of Dubrovnik and its hinterland are the Dubrovnik City Walls, Fort Lovrijenac, The Franciscan Church and Monastery, Stradun, Cavtat Cemetery, Minčeta Fortress, Church of St. Ignatius of Loyola, Church of Saint Blaise, Dominican Monastery, St. John's	-	-

Table 4. Achievement of threshold values in Dubrovnik (continuation from p.287, continued on pp.289-293).

Indicator	Indicator component	Value	Threshold	Achieved / Not achieved
Characterisation areas/sites of tourist value and tourism profiles		Fortress, Fort Bokar, Synagogue, Cathedra Treasury, Brsalje Street, and the Ston Old Town.	-	-
	Characterisation of tourist profile visiting heritage areas/sites	The average age of Dubrovnik guests is 42 years. Half of the guests in 2018 (51 %) were between 30 and 49 years old. Slightly older guests (45 years on average) come from the UK and Italy, while the younger guests come from Spain (39 years), Ireland (40 years) and Scandinavian countries (40 years).	-	-
	Economic data tourism	Tourists: EUR 170 per day. Visitors from ships on international cruises: EUR 51 (EUR 59 spent by passengers and EUR 26 spent by the crew).	-	-
Access capacity charge	Number of cruise ships	2017: 443 2018: 414 2019: 486 2020: 47 2021: 139 2022 (until July): 125	Not defined	-
	Number of passengers	2017: 709 517 2018: 732 431 2019: 768 924 2020: 4 323 2021: 110 130	Not defined	-

Table 4. Achievement of threshold values in Dubrovnik (continuation from pp.287-288, continued on pp.290-293).

Indicator	Indicator component	Value	Threshold	Achieved / Not achieved
		2022 (until July): 121 370		-
Capacity charge of the heritage area	Capacity of saturation sites	The maximum number of tourists allowed in the Old City of Dubrovnik is 8 000 per day. The recommended duration of the visit to the Old City of Dubrovnik is 6 hours.	-	-
	Accommodation by type	2 hotels 1 Bed and Breakfast (B&B) 2 hostels 29 private accommodation facilities Total: 34	-	-
	Tourist services by type in heritage areas	206 in the Accommodation sector 266 in Food and beverage service activities 164 in Travel agency, tour operator and other reservation services and related activities Total: 636	-	-
	Restoration by type in heritage areas	63 restaurants in the Old City of Dubrovnik – 6 fast food restaurants and 3 ice cream shops. The number of bars in the Old City of Dubrovnik is 22.	-	-

Table 4. Achievement of threshold values in Dubrovnik (continuation from pp.287-289, continued on pp.291-293).

Indicator	Indicator component	Value	Threshold	Achieved / Not achieved
Preservation level in optimal conditions (environmental and architectural) of sites of cultural value	Environmental level sites	Temperature 18,5°C Relative humidity 58 % Air pressure 1015,1 hPa Wind ESE 3,4 m/s	-	-
Optimal levels of overcrowding of people transit	Detection real transit of nº people/area/time	Max 2019: 10 240 Max 2020: 6 055 Max 2021: 7 986	Not defined	-
	Analytics anticipated reserves management: prediction of critical values agglomerations	N/A	Not defined	-
Optimal levels of tourist overnights	Saturation of accommodation facilities	Max 2016: 88,07 % Max 2017: 86,25 % Max 2018: 84,74 % Max 2019: 84,69 % Max 2020: 40,49 %	93 %	Achieved
Tourists perception about the adequacy of overcrowded site experience	Real time perception overcrowded: Social net	30,32 % positive 58,71 % neutral 10,97 % negative	Not defined	-
	Index perception post-experience overcrowded (sample)	Bad	Not defined	-
Residents perception about adequacy of overcrowded site experience	Real time perception overcrowded: Social net	6,25 % positive 84,54 % neutral 9,21 % negative	Not defined	-
Personal perception about adequacy of security site experience	Real time perception security: Social net	32,86 % positive 59,01 % neutral 8,13 % negative	Not defined	-
	Index perception post-experience security (sample)	Excellent	Not defined	-

Table 4. Achievement of threshold values in Dubrovnik (continuation from pp.287-290, continued on pp.292-293).

Indicator	Indicator component	Value	Threshold	Achieved / Not achieved
Personal perception about hygiene, sanitation and cleaning conditions site experience	Real time perception about hygiene, sanitation and cleaning conditions: Social net	33 % positive 50 % neutral 17 % negative	Not defined	-
	Index perception post--experience about hygiene, sanitation and cleaning conditions (sample)	Average	Not defined	-
Personal perception about cultural heritage preservation site experience	Index perception post-experience cultural heritage preservation (sample)	Good	Not defined	-
Optimal capacity of the urban cleaning service and décor	Ratio people/baskets/containers	Old City of Dubrovnik: 21,82 / 1000 inhabitants Dubrovnik: 26,22 / 1000 inhabitants	31,2 litter bins/ inhabitant	Not achieved
	Volume of solid waste collection	January: 3 t/day February: 3 t/day March: 3 t/day April: 6 t/day May: 6 t/day June: 6 t/day July: 8 t/day August: 8 t/day September: 6 t/day October: 6 t/day November: 3 t/day December: 3 t/day	Annual average + 10 %	Not achieved
	Intervention ratio hygiene service by area	Constantly during the day	1 time/day	Achieved
Capacity to maintain optimal citizen security	Crime rate (tourism and general) in target area	2016: 26,67 2017: 29,81 2018: 28,96	Crime rate: <45,2	Achieved
Capacity to ensure permitted ranges of contamination – basic environmental	Air pollution ranges in heritage environment stations	PM2,5: 19,46 – Good PM10: 25,296 – Good	Not defined	-

Table 4. Achievement of threshold values in Dubrovnik (continuation from pp.287-291, continued on p.293).

Indicator	Indicator component	Value	Threshold	Achieved / Not achieved
conditions in heritage areas		O3: 166,68 – Regular NO2: 15,037 – Very good SO2: 40,976 – Very good		
Fluid access to public transport in heritage areas	Waiting times in main public transport	Max 15-30 minutes on weekdays and Saturdays Max 15-35 minutes on Sundays	<10-15 min	Not achieved
Fluid access to parking spaces around heritage areas	percentage of free parking spaces in parking areas around the UNESCO Centre	During the tourist season (8 am - 10 pm): 0 % Out of the season (8 am - 4 pm): 0 % Out of the season (after 4 pm): around 5,37 % Weekends: around 6,72 %	>5 %	Not achieved
Optimal levels of access to housing in tourist areas by local population	Residential/tourist housing ratio	Residential: 41,7 % Tourist: 58,3 %	Not defined	-
	Housing value (m2): rent/buy	Houses (sale): 2016: 1453,48 EUR 2017: 1832,53 EUR 2018: 1396,38 EUR 2019: 1026,89 EUR 2020: 868,22 EUR Apartments (sale): 2016: 2352,78 EUR 2017: 2261,20 EUR 2018: 2404,91 EUR 2019: 2766,30 EUR 2020: 2553,41 EUR	Not defined	-
	Population movement flow analysis: historic centre – other areas	2011-2016: -25 %	Negative change of resident number related to the middle term time series	Not achieved

Table 4. Achievement of threshold values in Dubrovnik (continuation from pp.287-292).

Optimal levels of access to employment quality in tourist areas by local population	Rate and quality employment in target areas	2016: 43,64 % 2017: 47,37 % 2018: 47,75 % 2019: 47,45 % 2020: 43,21 % 2021: 43,08 %	Compared to region, cannot exceed the region	Not achieved
Optimal levels of access by residential population to local stores and products in tourist areas	Analysis of the commercial offer in the target area	38 shops – 5 retail shops, 2 bakeries, 3 pharmacies, seafood market, 1 convenience shop, 18 jewellery stores, 5 souvenir shops, 1 book store, 1 wine shop and 1 clothing shop	Not defined	-
Higher prices in target areas	Local price index	N/A	Variation cannot exceed the variation in the region	-
Optimal ratio tourists-residents around heritage areas	Ratio between the number of tourist overnights and the number of residents	Average 2016: 6,6 Average 2017: 7,5 Average 2018: 7,8 Average 2019: 8,2	<1	Not achieved

CONCLUSIONS

The City of Dubrovnik is one of the most visited Croatian tourist destinations and often a bad example of overtourism. However, the literature overview showed that it is important to determine its degree and effective measurement and monitoring of overtourism. In this article, the monitoring of tourist flows management has been done following the system of indicators developed by the Agency for sustainable Mediterranean cities and territories. The system of indicators consists of 21 indicators divided into 6 indicator groups. This system of indicators does not monitor only tourism and tourist flows, but also the protection level of heritage site, tourist city flows using innovations and smart technology, both tourists' and residents' perception using the social net analysis, capacity and quality of services and the quality of life of residents.

The first group of indicators provides the characterization of the areas of heritage value. Old City of Dubrovnik is an area of high heritage value, including the Old City, The Franciscan Church and Monastery, Upper Corner Tower Foundry Museum, Dubrovnik City Walls, Pile Gate, Synagogue, Church of Saint Blaise, Lokrum Island, Fort Lovrijenac and City Harbour. Dubrovnik is very popular among more solvent guests and cruise passengers who, in

pre-pandemic time, used to arrive in large numbers. The average consumption of tourists is EUR 170 per day while average consumption of cruise passengers is EUR 51. The second group of indicators, Building Site/Capacity Overcrowded measures direct effects on the spaces and infrastructures. In the City of Dubrovnik, environmental levels are favourable for achieving optimal conditions of sites of cultural heritage.

The second group of indicators analyses whether the concentration of the people in transit limits a normal flow of people. In the Old City of Dubrovnik, the number of visitors is limited to 8000 per day and during the period from 2019 to September 4, 2021, the number of days when the recommended number of visitors was exceeded is 47. Saturation of spaces and accommodation facilities in Dubrovnik has also achieved the target value, so it can be concluded that tourist saturation does not negatively affect spaces and infrastructure.

The next group of indicators analyses the perception of the tourist experience. The real time analysis of the social net posts showed that most of the experience related to overcrowding, security, hygiene, sanitation and cleaning conditions are neutral. On the other hand, the post-experience analysis showed that biggest problems of Dubrovnik are crowding, improperly disposed garbage, unpleasant odours and impossibility of waste separation. Dubrovnik is a very secure city with a high level of ecological and cultural heritage preservation and clean beaches.

Further group of indicators measures adequacy of access to strategic public services in the area and it shows scattered results in Dubrovnik. Positive results have been achieved in the hygiene service, since public spaces in the Old City are cleaned and garbage bins are emptied constantly throughout the day. Additionally, the level of crime rate in Dubrovnik is also very low, while the quality of air is good. Another positive aspect of the public services in Dubrovnik is public transport since the Old City is well connected with the rest of the city with 8 bus lines that run frequently. On the other hand, the number of litter bins is not sufficient for the number of people and the volume of solid waste collection throughout the year is much above the average. Another big problem of public services in Dubrovnik is a lack of parking spots around the Old City, i.e. in both the tourist season as well as out of season, it is almost impossible to find a parking spot during the working hours in the area.

Finally, the last group of indicators analyses the effect of touristification on residential population. In the City of Dubrovnik, local residents are greatly affected by mass tourism. In the 2011-2016 period the Old City of Dubrovnik lost a quarter of its residents and during the year. On average, the number of tourists exceeds the number of residents for about 7 times. Also, the ratio between residential and tourist dwellings in the heritage area is in favour of tourists and the prices of apartments in Dubrovnik are constantly rising so most of the local residents cannot afford to buy an apartment in the city. The problem with prices does not only concern apartments, but also the cost of living, i.e. Dubrovnik is the most expensive city to live in compared to other Croatian cities. Last, but not least, Dubrovnik's dedication to tourism is visible in the analysis of employment because most of the employers work in tourism sector. It is also obvious from the analysis of shops in the Old City where most of the stores are dedicated to tourists and their needs. These results are in line with Milano, Novelli and Cheer [2, 4], and Verrisimo, Breda, Guizi and Costa [5] conclusions that overtourism leads to decreased power parity of local residents and their dissatisfaction.

The developed monitoring system showed that the tourism flows are still not affecting the cultural heritage of the City of Dubrovnik, but it is greatly affecting local residents. Tourism is the most important sector in Dubrovnik and everything is dedicated to it. Huge number of tourists and cruise passengers represent the threat to the preservation of the Old City of Dubrovnik, and it is also negatively affecting the quality of local residents' life. Therefore, it is

of the greatest importance to manage tourism in a more sustainable way, to develop a holistic approach to the management of city flows and to find the balance between tourism and its economic contributions and sustainability.

Finally, it is important to emphasise that since cameras that count the number of visitors in the Old City of Dubrovnik have been installed, there were only several days when the number of visitors exceeded the maximum recommended number. Additionally, smart solutions for dealing with overtourism already exist, the application that predicts the number of visitors, which uses machine learning (the branch of artificial intelligence) to predict the number of people in the Old City of Dubrovnik on a given day. To predict the number, the machine learning algorithm uses various parameters such as the number of people coming from cruise ships, number of tourist arrivals and overnight stays as well as weather data such as temperature and precipitation. However, at the moment, the data are used by citizens and tourists to optimize planning of their visits to the Old City of Dubrovnik, but it should be also used in the management of tourist flows in the Old City of Dubrovnik.

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