



## Assessing the Effects of COVID-19 on Accommodations Availabilities and Prices

Matteo Giannettoni <sup>a</sup>, Angelica Lo Duca <sup>b\*</sup>, Andrea Marchetti <sup>b</sup>

<sup>a</sup> University of Pisa, Pisa, Italy.

<sup>b</sup> Institute of Informatics and Telematics, National Research Council, Pisa, Italy.

Received 01 February 2021; Revised 21 May 2021; Accepted 19 June 2021; Published 01 September 2021

### Abstract

In 2020, a new pandemic, named COVID-19, has been spreading all over the world, causing a reduction in activities, including in the tourism sector. This paper tries to quantify the effects of COVID-19 on accommodations, with a particular focus on prices trend and accommodation availability. Experiments simulated more than 400 accommodation bookings over the period of time before, during, and after the wave of the pandemic caused by COVID-19. The analysis was done for the city of Pisa, but it could be generalized to all the other cities, provided that there is an availability of data. The typology with the highest drop in availability was that of 2-star hotels, with a maximum decrease of 66%. Even the 4 and 3-star hotels were clearly affected by the pandemic, recording maximum drops of 36% for 4-star hotels and 25% for 3-star hotels. Regarding the analysis of prices trend, the categories most affected by the pandemic were hotels, hostels, and tourist villages, which recorded significant price increases. The major novelty of this paper involves the definition of a strategy, which can be used to analyze the impact of COVID-19 on accommodations, as well as the release of the DOTApY software for the extraction of data.

**Keywords:** Covid-19; OTA; Online Travel Agency; Pisa; Accommodation Facilities.

### 1. Introduction

At the end of 2019, a critical situation has occurred, determined by the spread of the Coronavirus pandemic [1], which is still ongoing at the time of writing. The COVID-19 outbreak, as it is called in this pandemic, was identified for the first time in China on December 31st, 2019, and then spread all over the world, reaching more than 100 million cases [2]. The COVID-19 outbreak is causing a global crisis, which also influences the tourism sector [3-5].

This research offers an overview of the situation of tourism in the city of Pisa before and during the first wave of COVID-19, taking into consideration the accommodation facilities and their categories. Two metrics are calculated and analyzed: the Accommodation Availability Index and the average price. Through the analysis of these two metrics, it is, therefore, possible to highlight the trends in the periods of interest of the research for different types of hotel structures, such as hotels, rent-a-room, apartments, B&B, etc.

This paper focuses on the data extracted from Booking.com. The extracted data related to the accommodation facilities and their prices in the periods from 1 December to 31 January and from 14 March to 9 June. Experiments were run by implementing software called DOTApY [6], which simulated accommodation searches for some given booking dates before, during, and after the lockdown caused by the COVID-19 pandemic. As a result, more than 8 million prices were extracted and further analyzed to evaluate the described metrics.

\* Corresponding author: [angelica.loduca@iit.cnr.it](mailto:angelica.loduca@iit.cnr.it)

 <http://dx.doi.org/10.28991/HIJ-2021-02-03-07>

➤ This is an open access article under the CC-BY license (<https://creativecommons.org/licenses/by/4.0/>).

© Authors retain all copyrights.

Interesting changes were highlighted in the availability indices, which in the majority of cases were significantly lower than the average and reached drops of 66% in the worst case, recorded for the 2-star hotel type, instead of relative to the type that was characterized by an increase in the availability index, Bed & Breakfast, the highest increase was recorded, with a maximum increase of 20%. About the price trend, in most of the types of accommodation structures taken into consideration, there were interesting trends of price increases in the lockdown period followed by a sharp drop in the following period. The remainder of the paper is organized as follows: Section 2 reviews the literature regarding trend price analysis and accommodation availability, Section 3 describes the employed methodology, and Section 4 discusses experiments and results. Finally, Section 5 describes conclusions and future work.

## 2. Related Work

Various criteria can be found in the literature for analysing the trend of prices of accommodation facilities [7, 8]. They can be grouped into the following categories: a) Seasonality; b) Spatial factor; c) e-Wom; d) Influence of reviews; e) Combination of several factors.

### 2.1. Seasonality and Booking Period

Dynamic pricing is a pricing strategy whereby various companies set flexible prices for products or services based on current market demands. This method has always been an integral part of the e-commerce sales strategy and is therefore heavily used in the sector of interest of the paper. It is interesting to note that the price varies according to different criteria, the one of all on which this section focuses is the seasonality or the booking period. The cost of a room can change a lot depending on the period, day, or even booking time [9]. Taking into consideration the price trends in different periods in Milan and the results obtained from the various analyses it is clear that the cost of a room falls on weekdays compared to holiday periods or weekends where the price is higher. By examining the results, substantial differences were noted in the working periods, thus highlighting further and more specific influencing factors such as the day of booking, room quality, special services, competition, and seasonality [10].

Observing the price changes about midweek bookings mostly occupied by workers and weekends which are generally occupied by leisure travel, there is a significant difference in price between the two research periods [11]. Another factor to consider is the fact that hotel managers are not always in line with the policies of Online Travel Agencies. Both using a different type of strategy for choosing prices for last-minute bookings. Hotels prefer to lower costs as the date of accommodation approaches to occupy as many rooms as possible. The choice is to prefer occupying a room, albeit at a lower price than keeping empty rooms. Instead, OTAs maintain a constant price or prefer to offer packages including multiple services. It is all based on the concept of supply and demand, if you think that the rooms will all be occupied then the cost of a room will start to increase [12].

### 2.2. Spatial Factor

The determining criterion besides a good price in the choice of the hotel is the convenient location of the hotel in addition to the services it offers [13, 14]. The proximity to the places of interest, the proximity to transport, the position concerning competitors are factors that establish the success of a structure. The analysis of the position is considered one of the most important for the hoteliers themselves [15]. The same pricing policies change concerning the geographical location of a structure facility managers need to consider this factor about organizational and price choices [16]. In addition to being useful in price trends, the spatial factor becomes fundamental in the creation of new structures that, to successfully enter the hospitality market, must consider competition criteria such as price, services offered but above all in the chosen geographical area. It is interesting to note that, strangely, the birth of an increasing number of accommodation facilities does not lead to a respective loss of value in the structures already in the area, it has been estimated that the agglomerations of structures occur with different types of structures, not going to therefore affect the neighbours market [17].

The study conducted by Kim et al. reserved for the Chicago area reinforces the previous theories according to which the position factor occupies the first places of classification and exclusivity of the hotel, with a consequent increase in rates. The work is focused on studying and deepening the spatial grouping models of the relationships between the price and the characteristics of the hotels across the market. The article highlighted how fundamental factors for the individualization of the price are the attributes of the site such as size, age, class, and quality of service and attributes of the situation such as distances from airports, highways, and tourist attractions, through a precise study of the area in which the various structures were located [18].

### 2.3. eWOM

By eWOM we mean "Electronic Word of Mouth" and can be described as any positive or negative statement by possible, current, or past customers, relating in this case to accommodation facilities, published on the internet and therefore reachable by a large number of people. The main features of the eWOM can be summarized in:

- Interaction between people who do not know each other;
- Anonymous form;
- Can be written by anyone with Internet access;
- There is no time limit;
- The content can be more or less detailed.

The criteria mentioned above constitute on the one hand an additional factor to entice the customer to review a structure (such as anonymity), but on the other, they are unreliable parameters because in many cases they are difficult to prove. Word of mouth information technology is a fundamental factor in the choice of prices for accommodation facilities, which can be compared to the type of structure itself, which according to many is the fundamental variable in the choice of price [19]. This section introduces various researches that focus on the value that eWom has on choosing the price of accommodation. According to an in-depth study of online evaluations, it was established that the positive reputation of the structures generates a substantial price increase and a significantly better occupancy rate than those with a lower evaluation [20]. Furthermore, taking into particular consideration a small number of hotels in Krakow, their ratings and prices both in the low and in the high season, it was highlighted that the rating is fundamental for hotels, especially in periods when the tourist flow is less concentrated [21].

Online reputation is gaining more and more consideration, thus surpassing the traditional star rating. According to Abrate and Viglia (2016), those involved in pricing strategies in the tourism sector should increasingly take into consideration the online reputation factor with the increase in popularity of online travel agencies characterized by a manic concentration on the collection of information regarding accommodation facilities [22].

## 2.4. Reviews from Online Travel Agencies

Evaluating the needs and understanding the desires of consumers has always been one of the success factors of a hotel structure regardless of its type. Through the reviews, the strengths and weaknesses of a structure are highlighted. Today, most travelers say that the higher the number of positive online reviews, the more the choice will be oriented towards that structure. Furthermore, the number of reviews available is fundamental, a limited number of ratings, for most travelers, are not sufficient for a complete judgment. The impact of online reviews on hotel services and the improvement of the quality of their services is fundamental for an accommodation facility. Paul Phillips uses Swiss nationwide online review data collected from 68 different online platforms, combined with review data from 442 hotels. The main aspects considered are physical aspects, quality of food, quality of drinks, and human relationships. For human relations, reference is made to relations, for example, between the staff of the structure with customers and communications with the media. The data offer a complete picture of how more positive reviews on the characteristics of the hotels such as room quality, internet connection, and services offered to increase the number of requests from customers and as already written above, bring a substantial impact on the probability of choice by customers [23].

The online reviews offer not only parameters in which the probable traveler can confront themselves but also an important starting point for any improvements to their accommodation facilities. Bona Kim analyses the factors known as satisfactory and unsatisfactory based on Herzberg's two-factor theory. Herzberg's factors are divided into hygienic factors which include, for example, supervision by superiors, human resources policies, working conditions, interpersonal relationships, etc. The second factor is called the motivating factor and are those factors such as the recognition of the results achieved, responsibility, qualifying work, professional growth, and career advancement.

The use of this approach was fundamental for the comparison between full-service and limited-service hotels, which show different levels in customer expectations depending on the basic services they offer. The analysis took into account 919 reviews indicating the satisfaction and dissatisfaction of 100 full-service hotels in New York through TripAdvisor. It emerged from the relevant data that the most discussed topic, for both categories analyzed, is "the staff and their attitude". For the management of a hotel, therefore, the customer satisfaction and non-satisfaction review is fundamental, which becomes basic both for those who decide to stay in a particular hotel, but also for the managers themselves who try to understand what their customers are looking for and what competition offers better [24].

Sánchez-Franco et al. (2019) takes into consideration 47,172 reviews of 33 hotels in Las Vegas (USA), which are registered on Yelp from the period of March 2005 to January 2017, trying to extrapolate all aspects that bind the customer to the hotel. Yelp is a popular online review site where travelers can exchange views and content about the holiday. The extrapolation of the reviews are necessary for subsequent analyses such as highlighting the services considered extremely important for customers and which therefore can allow their return. 53% of travelers are reluctant to book a property that does not have reviews based on this truth. It is therefore important to reiterate the importance of reviews and their study.

Among the many factors taken into consideration, the one of fundamental importance is hospitality, it is extrapolated from the post-customer experience reviews. The results show that for research predictions based on hotel evaluation, "recall" and "precision" are equally important determining classifiers. By recall, we mean the ratio between the number of correct predictions of an event (class) on the total number of times the model predicts it. Instead, precision is defined as the ratio between the correct predictions for a class on the total of cases in which it actually occurs [25].

The importance of reviews and their positive trend is related to the intention of booking a hotel. One possible explanation is the close link that exists between positive reviews and customer bookings both influenced by superficial (demographic) factors and individual preferences. The experiments conducted by Chan et al. (2017) were carried out in Germany and Macau and the final result implies the correlation between the degree of a positive evaluation of a structure and the stay in it. The research also focuses on customer decision-making processes which should be facilitated by websites. They should find new ways to expose users to reviews written with the same preferences to offer person-related services and hotels [26]. Two quality parameters examined by Ögüt and Taş (2012) are star ratings and customer ratings on the sale of hotel rooms in Paris and London. The results show that at 1% of the increase in the evaluation of online customers, sales for rooms rise by 2.68% in Paris and 2.62% in London. It was also found that the more positive evaluations the structure has, the higher the prices. Hotels with more stars are also more sensitive to online customer ratings than those with fewer stars [27].

## 2.5. Combination of Multiple Factors

The price trend is influenced by several characteristics. In fact, there is not a single factor to determine the cost of a room, but multiple: location, period, reviews, facility services, and competition. Changes in airport taxes and the same cost of flights also influence the demand that structures receive with a consequent increase in prices. Pawlicz and Napierala (2017) in their work aims to highlight the attributes that characterize and influence the prices of accommodation facilities [28]. The goal is to find factors common to price changes that may depend: on the services that the structures themselves offer, on the location or season in which a customer books. The price trend was estimated by checking the classification of various factors both in public and private systems (such as Online Travel Agencies). It also appears that the star rating is considered one of the determining factors together with: brand, hotel size, chain affiliation, and associated services. It was thus estimated that as the stars increase, prices increase, in fact for each star obtained they can rise by about 25-36%. To achieve the objectives set, factors not considered in depth from previous research such as the proximity to the airport and position in relation to the city center were also considered. This research is important for the awareness of the managers of the structures regarding the consideration of the geographical factor in the choice of prices.

Another criterion that significantly influences the price change is market accessibility or the organization's ability to affect the foreign market thereby increasing revenues [29]. This factor is of fundamental importance in the geographical area of reference (Caribbean) of the study carried out by Yang et al. (2016), as Caribbean tourism is occupied for almost all cases by foreign customers. This influence is determined by several factors such as the quality of the structure, user rating, hotel class, and commercial affiliation. The price model is therefore conditioned by the accessibility which in addition to being modeled by the factors mentioned above, is substantially influenced by the spatial factor, and for this reason, it becomes even more indicative and fundamental for identifying the marketing models suitable for all those structures belonging to areas characterized by particular geographical factors such as island locations or difficult to reach locations. About price trends, another possible influence is the drop in prices on flights and means of transport which, by generating growth in access, causes an increase in arrivals and demand relating to the occupation of accommodation with a clear increase in price. In fact, as demand increases, the price generally increases in all sectors.

In conclusion, the quality of the services of the accommodation, the positive evaluation, the typology, the position, and the market accessibility indicates possible criteria for the price increase. The changes in the cost of a room depending on the type of strategy that a hotel or an Online Travel Agency proposes [16]. In fact, through the extrapolation of data from three different Online Travel Agencies, Sunny Sun has established that OTAs mostly use bundled sales, that is, offers include more services, while the criterion of "last minute" sale is adopted as a percentage lesser than online agencies, but preferred by hotel managers who aim to optimize the occupation of the remaining rooms. In fact, an occupied room is preferable, even at a lower cost, than a free room. Besides, it is of fundamental importance to note that in online agencies the closer a certain date of accommodation is, the more the price increases, while hotel managers tend to lower the cost more and more to optimize and monitor the remaining rooms.

## 3. Research Methodology

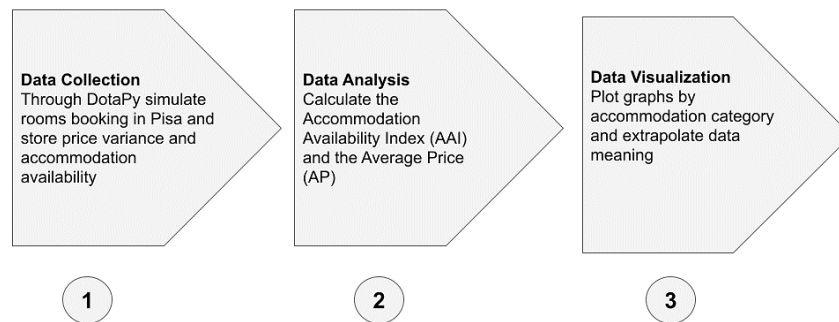
The objective of this analysis is to highlight the percentage of available structures, related to the city of Pisa, in the period prior to COVID-19, during the lockdown period caused by the pandemic and in the period immediately

following the almost total reopening. Pisa, in fact, is an excellent reference point for research of this type as a tourist destination chosen by tourists from all over the world, thus making tourism and therefore accommodation facilities indispensable for the city's economy. This situation, therefore, allows us to extract a large amount of reliable data for our studies. Table 1 shows the analyzed periods. Time is split into three parts: before, during, and after the lockdown caused by the COVID-19 pandemic [30].

**Table 1. Definition of periods of times analyzed for this study**

	Before the lockdown	Lockdown	After the lockdown
Start date	December 1, 2019	March 14, 2020	May 18, 2020
End date	January 31, 2020	May 17, 2020	June 9, 2020

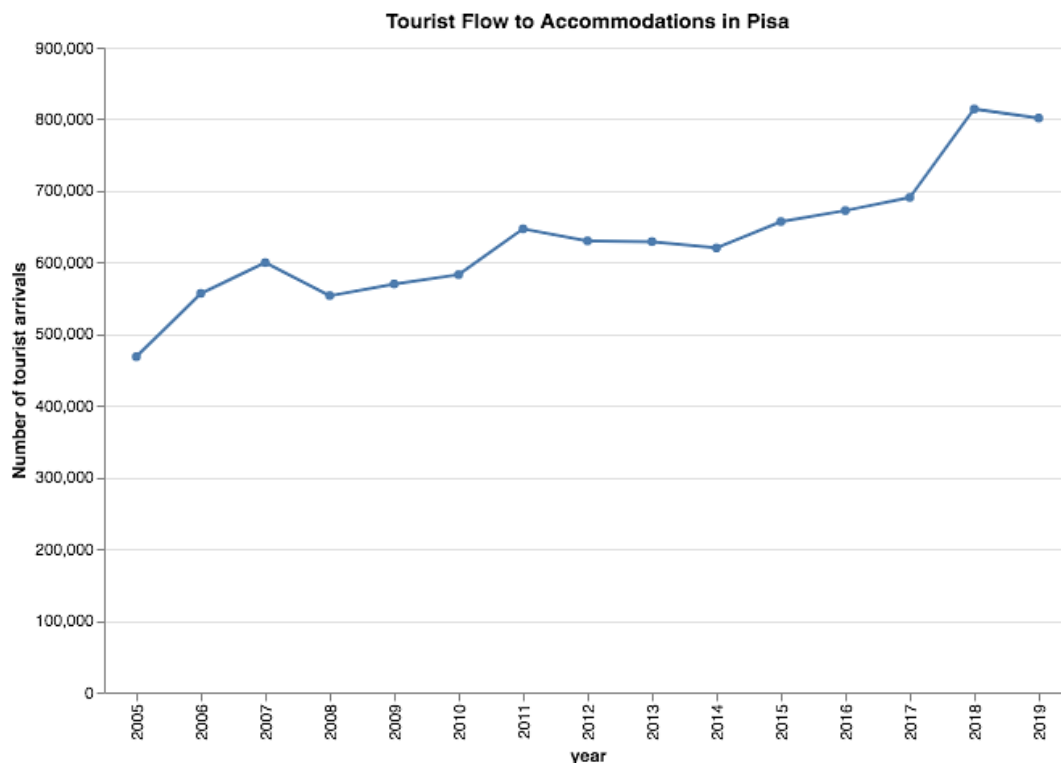
Figure 1 shows the workflow followed in this paper. There are three steps: Data Collection, Data Analysis and Data Visualization.



**Figure 1. Research workflow**

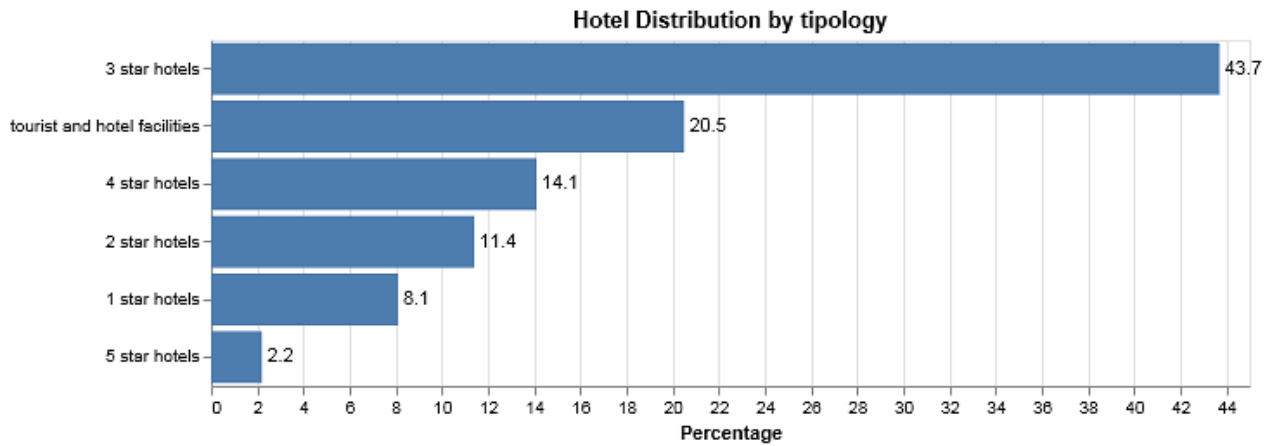
### 3.1. Pisa

Pisa, Italy, has been a UNESCO World Heritage Site since 1982, considered an important tourist destination chosen by hundreds of thousands of people a year. The Pisan tourism sector is certainly a fundamental ingredient for the economy of the city where there has been a positive trend in attendance over the past few years. It can be easily found in Figure 1 built with the most recent ISTAT data [31].



**Figure 2. Number of tourists per year relative to the city of Pisa**

From 2005 to 2019 there has been an increasing acceptance of tourists in hotel structures until reaching a peak in 2018. Pisa holds the thirtieth position among the most visited Italian municipalities by the number of presences in accommodations in Italy. According to the data provided by ISTAT on the Pisan municipality, 185 hotel facilities are counted, the distribution of which is shown in Figure 2:



**Figure 3. Percentage breakdown of hotels in the Pisan municipality**

As shown in Figure 3, as much as 43.8% of the hotels in the Pisan area are occupied by 3-star hotels, followed by the Hotel Tourist Residences (20.5%), 4-star hotels (14.1%), 2-star hotel (11.4%), 1-star hotel (8.1%) and in conclusion 5-star hotel (2.2%).

### 3.2. Data Collection

Data was extracted from Booking.com through the DOTApY software. Booking.com permits to book a certain room, at a given time of the search, for a given time of booking. For example, today (time of booking 2021 January 13th) I can book a room for the time of booking 2021 June 16th. Thus, in our experiments, we consider two times: the search time and the booking time. More formally, by search time we mean the day on which the search was made, by booking time we mean the date of stay considered for the extraction of the price of the accommodation facilities. Table 2 shows the search and booking times involved in our experiments. Every day during the *search time*, DOTApY performed 214 one-day searches for accommodations in Pisa on Booking.com, corresponding to every day included in the *booking times*. As a result, 8,176,732 records were extracted, relating to 468 accommodations in the Pisa area with a maximum distance of 5 km from the historic center.

**Table 2. Definition of periods of interest**

	Start date	End date	Missing dates
Search time	December 1, 2019	June 9, 2020	February 1, 2020 - March 13, 2020
Booking time	May 1, 2020	November 30, 2020	-

**Table 3. Shows extracted information and Table 4 illustrates a practical example**

Attribute	Description
Name	Name of the accommodation
Category	Category of the accommodation
Price	Value of the price for a single room into a one-day stay
bookingTime	Booking time
searchtime	Search time



**Table 4. Data extracted concerning the accommodation facilities for the Info & Review module**

Name	Category	Price	BookingTime	SearchTime	# stars
Royal Victoria Hotel	Hotel	63	2020-06-17	2019-12-01	3
Hotel Terminus & Plaza	Hotel	60	2020-06-17	2019-12-01	3
B&B Pisa Tower	Bed & breakfast	71	2020-06-17	2019-12-01	-
Casa San Tommaso	Rent-rooms	59	2020-06-17	2019-12-01	-
Pisa Train Station Hostel	Hostel	21	2020-06-17	2020-05-27	-
La Casa di Nila	Apartment	79	2020-06-17	2020-05-27	-
Grand Hotel Bonanno	Hotel	102	2020-06-17	2020-05-27	4
Hotel Roma	Hotel	64	2020-06-17	2020-05-27	3
Garibaldi B&B	Bed & breakfast	79	2020-06-17	2020-06-01	-
Il Caprifoglio	Holiday Home	69	2020-06-17	2020-06-01	-

### 3.3. Metrics

This type of analysis aims to understand how much the COVID-19 pandemic has affected the tourism sector, identifying the availability rates in the periods before and after the first wave of the COVID-19 pandemic. We consider two types of metrics: the Accommodation Availability Index (AAI) and the Average Price (AP). Both these metrics are calculated based on two criteria: a) category of accommodation b) the number of stars if the type is hotel. The different types of accommodations identified on Booking.com are Hotel, Bed & Breakfast, Rent-room, Holiday home, Hostel, Residence, Tourist village, Camping, Apartment. Let us suppose that  $N_c$  is the total number of accommodations belonging to category  $c$  and  $N_{dc}$  is the number of accommodations bookable at day  $d$  and belonging to category  $c$ . The following metrics are analyzed:

Accommodation Availability Index (AAI). By the availability of accommodation we mean an accommodation that can be booked, that is, an accommodation either open in the booking time or with places available. The AAI for a given day  $d$  and a given category  $c$  is calculated as the percentage of the ratio between the number accommodations of category  $c$  available in the day  $d$  and the total number of accommodations:

$$AAId = \frac{N_{dc}}{N_c} \times 100 \quad (1)$$

Average Price (AP). Let us suppose that  $P^{(i)}_{dc}$  is the price of accommodation  $i$  (belonging to category  $c$ ) on day  $d$ . The Average Price AP for a category  $c$  on day  $d$  is calculated as the sum of the prices of all accommodations belonging to  $c$  on  $d$ , divided by the number of available accommodations of category  $c$ .

$$PT = \frac{\sum_{i=1}^{N_{dc}} P^{(i)}_{dc}}{N_{dc}} \quad (2)$$

## 4. Discussion

As already specified in the previous sections, the objective of this paper involves the analysis of the availability and trends of prices of accommodations before, during and after the first wave of the COVID-19 pandemic. A reasonable hypothesis states that accommodations availability increased during the lockdown period, while prices decreased, in order to incentivize clients to book a room.

In order to test this hypothesis, some tests were done, considering as booking time the date of stay on June 17th, a very important date for the city of Pisa as it is the feast in honor of the patron saint of the city.

### 4.1. Accommodation Availability Index

Figures 4 and 5 show the trend of the AAI of all the accommodations and the AAI of hotels divided by stars, respectively. The categories that suffered the most and those that least affected the effects of the pandemic in relation to the two different metrics were highlighted. Concerning the analysis of the availability indices, it emerged that the typology with the highest drop in availability was that of 2-star hotels with a maximum decrease of 66%. Even the 4

and 3-star hotels were affected by the pandemic, recording maximum drops of 36% for 4-star hotels and 25% for 3-star hotels. There is also a significant drop in availability in the Holiday Home category with a maximum drop of 10%.

The typologies that instead recorded an increase in the availability index were that of the Bed & Breakfast with a maximum increase of 20%, the typology Affittacamere with a maximum availability increase of 14%, and finally, the typology Apartment where there is a maximum increase of 9%. For the other typologies taken into consideration by the paper, there were no particular trends in relation to the availability index.

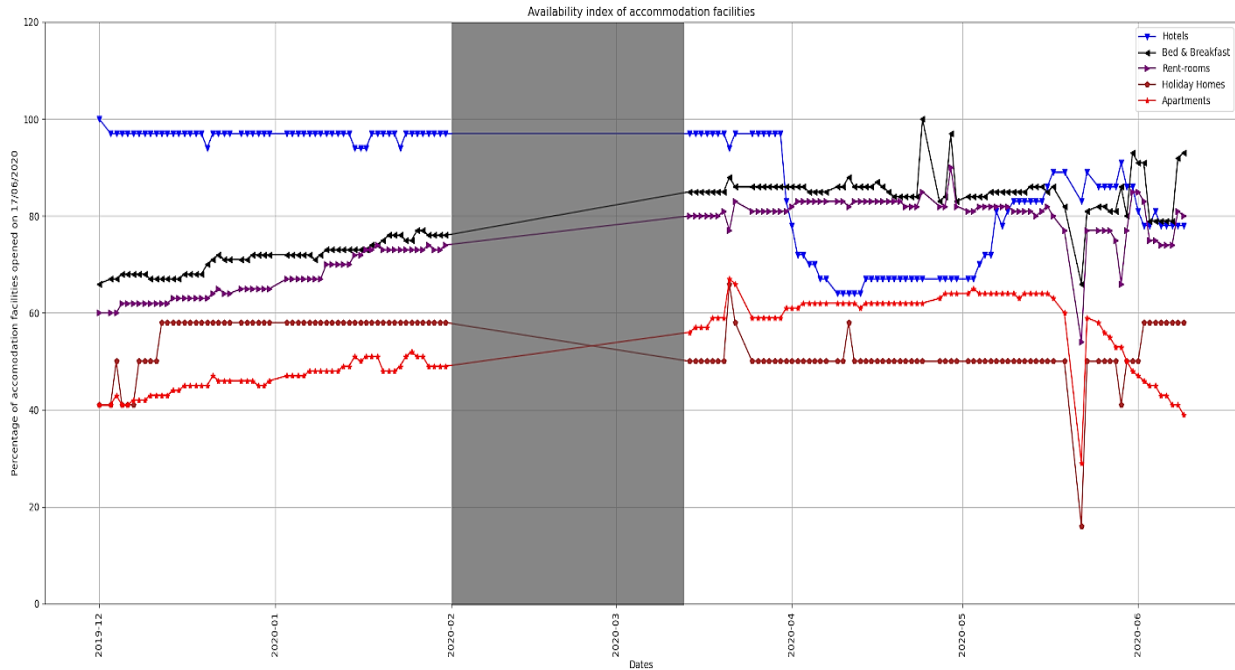


Figure 4. Availability index of accommodation facilities

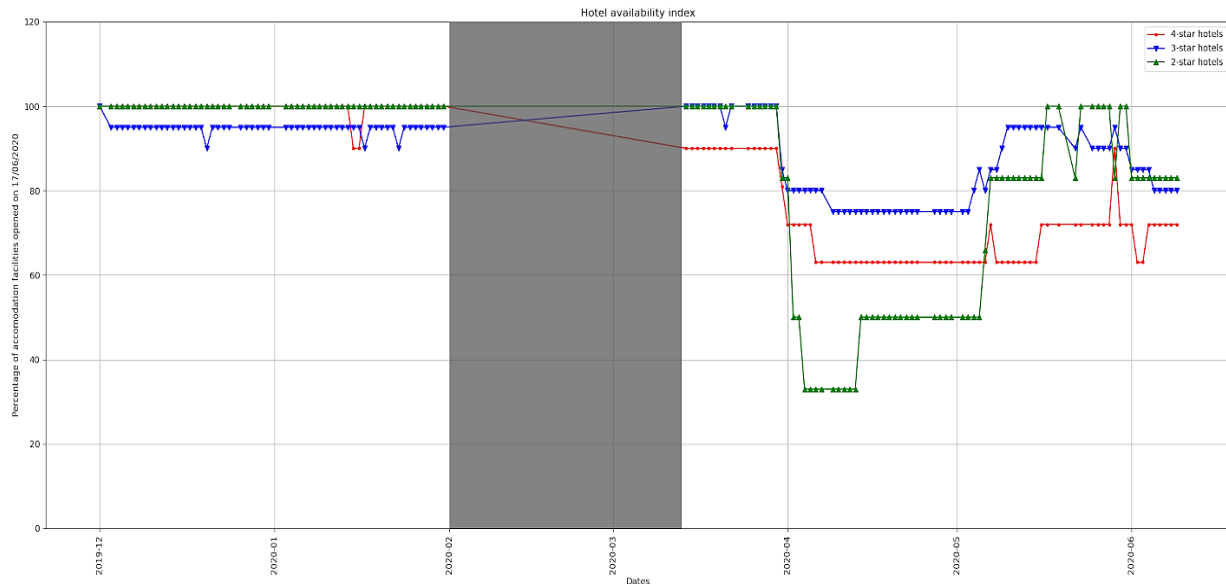


Figure 5. Hotel availability index

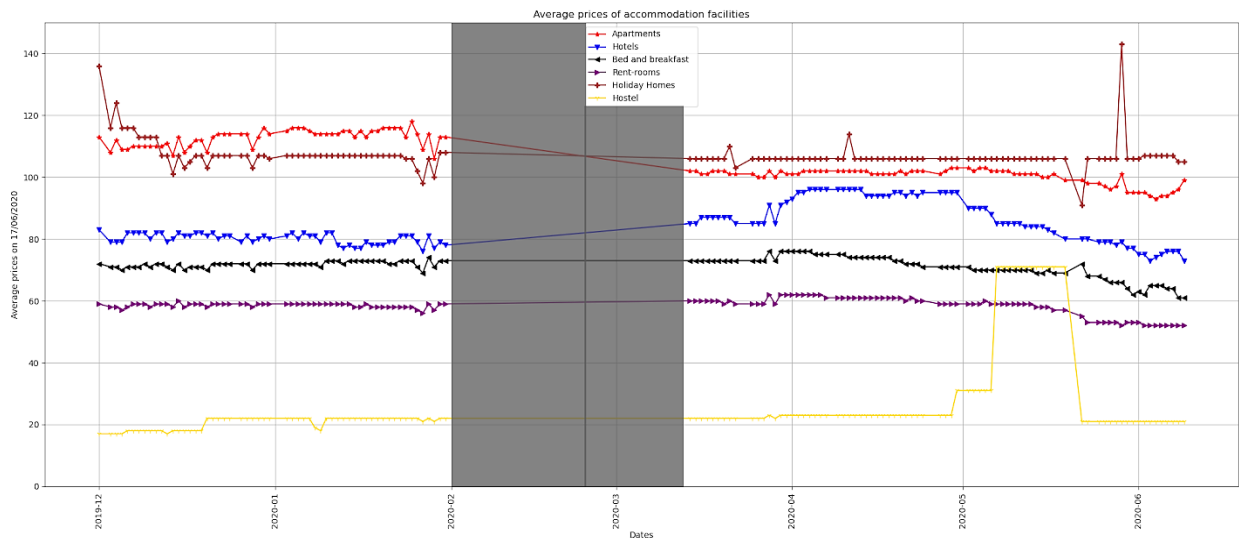
It is interesting to note that in the 2-star, 3-star, and 4-star Hotel category, there was a high percentage increase in the availability index on 7 May 2020, probably due to the pressure of the regions for the early reopening of many activities.

The described results partially confirm the original hypothesis, which stated an increase in accommodations availability. In fact, some categories experienced an increase, while others an incredible decrease. Regarding the decreasing availability for some categories, this is probably due to the fact that some accommodations categories were closed during the lockdown period.



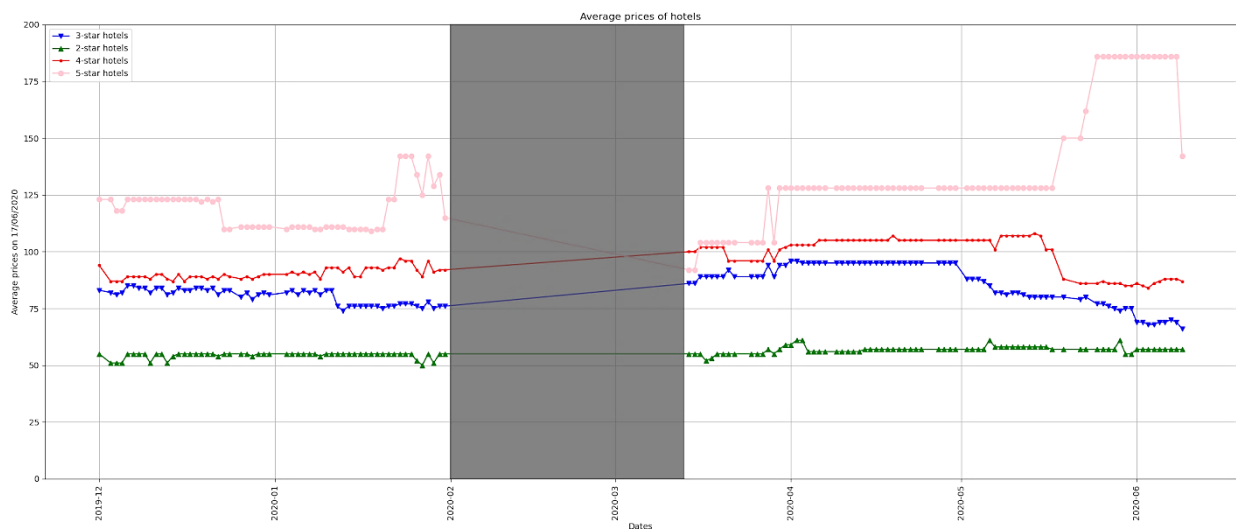
## 4.2. Average Price

Figures 6 and 7 show the AP of all the accommodations and the AP of hotels divided by stars, respectively. In Figure 7, on the other hand, the trend in prices by type of hotel divided by stars is analyzed in detail. 2, 3, 4, and 5-star hotels were taken into consideration as the data in possession were deemed more interesting for the research.



**Figure 6. Average prices of accommodation facilities**

The categories most affected by the pandemic were hotels (except for the 1-star ones), hostels, and tourist villages which recorded significant price increases. In more detail, the average prices of the 3 and 4-star hotels increased by around 12 euros, compared to the average, during the lockdown period. The prices of the 5-star hotels were found to remain constant for the lockdown period but recorded a considerable increase, of around 55 euros, compared to the average in the period following the lockdown. About hostels, there was a brief increase in the lockdown period of around 44 euros.



**Figure 7. Average prices of Hotels**

The prices for the type of holiday village registered a peak of around 17 euros. The apartment type is the only one that has registered a decrease in prices since the beginning of the lockdown, which is always below average and which drops even more in the period following the lockdown. In summary, it is noted that most of the typologies recorded a price increase in the lockdown period, but after this period, the prices returned to the average or were even lower than the average. This trend highlights the different pricing strategies adopted by the accommodation facilities for the restart. It should be noted that 4- and 3-star hotels, bed & breakfasts, rent-a-room, residences, and apartments adopt a common strategy of lowering prices. This choice is not shared by the remaining types that either keep the prices in the average before the lockdown period or, as in the case of 5-star hotels, significantly increase the price. The analysis demonstrated that the initial hypothesis was wrong for almost all categories, since accommodations owners preferred to increase prices rather than decrease them. This is due to a specific marketing policy.

## 5. Conclusion

This paper focused on the analysis of trends in prices and accommodations availability related to accommodations located in Pisa before, during, and after the first wave of the COVID-19 pandemic. The analysis demonstrated that the typology of hotels which suffered the effects of COVID-19 in terms of availability was 2-star hotels, followed by 4- and 3-star hotels. The categories of accommodations, which experienced an increase in prices were hotels, hostels, and tourist villages. The strong point of this paper involves the definition of a methodology to analyse two metrics, the availability index and the average price. This methodology has been applied to the city of Pisa, but it can be generalized to all cities, provided that there is availability of data. Potentially, the proposed methodology can also be applied to the second wave of the COVID-19 pandemic. In future work, a comparison among different cities could be established by highlighting which cities suffered the most from the effects of the COVID-19 pandemic in terms of availability and prices trend. As a further aspect, this paper exploited the DOTApY software, which is a very powerful tool, which permits a user to extract information from OTAs. DOTApY is completely open source, so the code can be extended to also support other features and potentially other OTAs.

## 6. Declarations

### 6.1. Author Contributions

M.G. collected data, contributed to design the analysis, performed the analysis, wrote the code and wrote the paper. A.L.D. contributed to design the analysis and wrote the paper. A.M. contributed to design the analysis and revised the paper. All authors have read and agreed to the published version of the manuscript.

### 6.2. Data Availability Statement

The DOTApY software can be downloaded from the following link: <https://github.com/gmt1996/DOTApY>. Currently data is not released as open source.

### 6.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

### 6.4. Institutional Review Board Statement

Not applicable.

### 6.5. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## 7. References

- [1] Rothan, H. A., & Byrareddy, S. N. (2020). The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. *Journal of Autoimmunity*, 109, 102433. doi:10.1016/j.jaut.2020.102433.
- [2] Chinazzi, M., Davis, J. T., Ajelli, M., Gioannini, C., Litvinova, M., Merler, S., ... Vespignani, A. (2020). The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak. *Science*, 368(6489), 395–400. doi:10.1126/science.aba9757.
- [3] Suau-Sanchez, P., Voltes-Dorta, A., & Cugueró-Escofet, N. (2020). An early assessment of the impact of COVID-19 on air transport: Just another crisis or the end of aviation as we know it? *Journal of Transport Geography*, 86, 102749. doi:10.1016/j.jtrangeo.2020.102749.
- [4] Gerwe, O. (2021). The Covid-19 pandemic and the accommodation sharing sector: Effects and prospects for recovery. *Technological Forecasting and Social Change*, 167, 120733. doi:10.1016/j.techfore.2021.120733.
- [5] Jang, S., Kim, J., Kim, J., & Kim, S. (Sam). (2021). Spatial and experimental analysis of peer-to-peer accommodation consumption during COVID-19. *Journal of Destination Marketing & Management*, 20, 100563. doi:10.1016/j.jdmm.2021.100563.
- [6] Giannettoni, M., Marchetti, A. Lo Duca, A. (2020). DotaPy: Using Python Selenium to Extract Information and Prices Trends from Online Travel Agencies. Technical Report. Available online: <https://www-old.iit.cnr.it/en/node/58840> (accessed on September 2020).
- [7] Chang, C., & Li, S. (2021). Study of Price Determinants of Sharing Economy-Based Accommodation Services: Evidence from Airbnb.com. *Journal of Theoretical and Applied Electronic Commerce Research*, 16(4), 584–601. doi:10.3390/jtaer16040035.
- [8] Voltes-Dorta, A., & Sánchez-Medina, A. (2020). Drivers of Airbnb prices according to property/room type, season and location: A regression approach. *Journal of Hospitality and Tourism Management*, 45, 266–275. doi:10.1016/j.jhtm.2020.08.015

- [9] Vives, A., Jacob, M., & Aguiló, E. (2018). Online hotel demand model and own-price elasticities: An empirical application in a mature resort destination. *Tourism Economics*, 25(5), 670–694. doi:10.1177/1354816618800643.
- [10] Guizzardi, A., Pons, F. M. E., & Ranieri, E. (2017). Advance booking and hotel price variability online: Any opportunity for business customers? *International Journal of Hospitality Management*, 64, 85–93. doi:10.1016/j.ijhm.2017.05.002.
- [11] Mohammed, I., Guillet, B. D., Law, R., & Rahaman, W. A. (2020). Predicting the direction of dynamic price adjustment in the Hong Kong hotel industry. *Tourism Economics*, 27(2), 346–364. doi:10.1177/1354816620903900.
- [12] Sun, S., Law, R., & Tse, T. (2015). Exploring price fluctuations across different online travel agencies: A case study of room reservations in an upscale hotel in Hong Kong. *Journal of Vacation Marketing*, 22(2), 167–178. doi:10.1177/1356766715592663.
- [13] Chang, S. E., Hsieh, Y.-J., Chen, C.-W., Liao, C.-K., & Wang, S.-T. (2006). Location-Based Services for Tourism Industry: An Empirical Study. *Lecture Notes in Computer Science*, 1144–1153. doi:10.1007/11833529\_115.
- [14] Suárez-Vega, R., & Hernández, J. M. (2020). Selecting Prices Determinants and Including Spatial Effects in Peer-to-Peer Accommodation. *ISPRS International Journal of Geo-Information*, 9(4), 259. doi:10.3390/ijgi9040259.
- [15] Masiero, L., Yang, Y., & Qiu, R. T. R. (2019). Understanding hotel location preference of customers: Comparing random utility and random regret decision rules. *Tourism Management*, 73, 83–93. doi:10.1016/j.tourman.2018.12.002.
- [16] Napierała, T. (2017). Internetization of selling hotel rooms in metropolitan area of Łódź (Poland). *Journal of Geography, Politics and Society*, 7(3), 19-30.
- [17] Urtasun, A., & Gutiérrez, I. (2006). Tourism agglomeration and its impact on social welfare: An empirical approach to the Spanish case. *Tourism Management*, 27(5), 901–912. doi:10.1016/j.tourman.2005.05.004.
- [18] Kim, J., Jang, S., Kang, S., & Kim, S. (James). (2020). Why are hotel room prices different? Exploring spatially varying relationships between room price and hotel attributes. *Journal of Business Research*, 107, 118–129. doi:10.1016/j.jbusres.2018.09.006.
- [19] Sánchez-Pérez, M., Illescas-Manzano, M. D., & Martínez-Puertas, S. (2019). Modeling hotel room pricing: A multi-country analysis. *International Journal of Hospitality Management*, 79, 89–99. doi:10.1016/j.ijhm.2018.12.014.
- [20] Nakamura, Y., & Oomiya, N. (2020). An analytical examination of accommodation sales and the importance of electronic “word-of-mouth” appraisals via internet travel sites. *Journal of Global Tourism Research*, 5(1), 43–50. doi:10.37020/jgtr.5.1\_43.
- [21] Kościółek, S. (2017). Role of e-WOM in hospitality market pricing. *Journal of Economics & Management*, 29, 58-74.
- [22] Abrate, G., & Viglia, G. (2016). Strategic and tactical price decisions in hotel revenue management. *Tourism Management*, 55, 123–132. doi:10.1016/j.tourman.2016.02.006.
- [23] Phillips, P., Barnes, S., Zigan, K., & Schegg, R. (2016). Understanding the Impact of Online Reviews on Hotel Performance. *Journal of Travel Research*, 56(2), 235–249. doi:10.1177/0047287516636481.
- [24] Kim, B., Kim, S., & Heo, C. Y. (2016). Analysis of satisfiers and dissatisfiers in online hotel reviews on social media. *International Journal of Contemporary Hospitality Management*, 28(9), 1915–1936. doi:10.1108/ijchm-04-2015-0177.
- [25] Sánchez-Franco, M. J., Navarro-García, A., & Rondán-Cataluña, F. J. (2019). A naive Bayes strategy for classifying customer satisfaction: A study based on online reviews of hospitality services. *Journal of Business Research*, 101, 499–506. doi:10.1016/j.jbusres.2018.12.051.
- [26] Chan, I. C. C., Lam, L. W., Chow, C. W. C., Fong, L. H. N., & Law, R. (2017). The effect of online reviews on hotel booking intention: The role of reader-reviewer similarity. *International Journal of Hospitality Management*, 66, 54–65. doi:10.1016/j.ijhm.2017.06.007.
- [27] Ögüt, H., & Onur Taş, B. K. (2012). The influence of internet customer reviews on the online sales and prices in hotel industry. *The Service Industries Journal*, 32(2), 197–214. doi:10.1080/02642069.2010.529436.
- [28] Pawlicz, A., & Napierała, T. (2017). The determinants of hotel room rates: an analysis of the hotel industry in Warsaw, Poland. *International Journal of Contemporary Hospitality Management*, 29(1), 571–588. doi:10.1108/ijchm-12-2015-0694.
- [29] Yang, Y., Mueller, N. J., & Croes, R. R. (2016). Market accessibility and hotel prices in the Caribbean: The moderating effect of quality-signaling factors. *Tourism Management*, 56, 40–51. doi:10.1016/j.tourman.2016.03.021.
- [30] Gazzetta Ufficiale (2020). “Misure urgenti per fronteggiare l'emergenza epidemiologica da COVID-19”. Available online: <https://www.gazzettaufficiale.it/eli/id/2020/03/25/20G00035/sg> (accessed on November 2020).
- [31] National Institute of Statistics (ISTAT). (2020). Tourism and Covid-19. Available online: [https://www.istat.it/it/files/2020/04/STATISTICATODAY\\_TURISMO.pdf](https://www.istat.it/it/files/2020/04/STATISTICATODAY_TURISMO.pdf) (accessed on September 2020).