The Effect of COVID-19 on the Venetian Retail and Hospitality Sectors

An Interactive Qualifying Project Report submitted to the faculty of Worcester Polytechnic Institute in fulfillment of the requirements of the Degree of Bachelor of Science

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Authorship

The individual contributions of each team member are described below.

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Contributed to literature review and was responsible for the results and analysis chapter. Responsible for the development of graphics, section 4.3 of the methodology chapter, the secondary website that houses all visuals, the analysis sections of the presentation, and data collection.

Carmellitta Le
Wrote the background section of the final report. Responsible for keeping the project on track, contributed to the methodology chapter, and wrote the proposal conclusion. Completed half of the final presentation, the booklet, and data collection.

Mago Sheehy
Developed the Venice Shops application, wrote the technical addendum, and created the instruction manual for the application. Mago wrote the introduction chapter, wrote most of the literature review, wrote sections 4.1 and 4.2 of the methodology, and contributed heavily to the final presentation.

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Chapter 1: Introduction

Venice is one of Italy's most beautiful, historical, and unique cities, so it is no surprise that it is one of the most popular tourist destinations in the world. Over 60,000 tourists are estimated to visit the city every day (Warren, 2021), and these tourists fuel the Venetian economy. However, maintaining a balance that also supports local residents can be difficult. For example, the city is home to thousands of shops that rely on tourists to survive, many of which neglect the local population's needs entirely to capitalize on the lucrative market for tourism-related goods. The hospitality sector, including restaurants, hotels, and Airbnbs that make up this domain, also depend on the influx of travelers for revenue while occupying valuable real estate. This economic model is more balanced when tourism is booming, but a dip in visitors can pose serious problems to both businesses and residents and bring the stability of the economy as a whole into question.

The COVID-19 pandemic has altered many aspects of life for people worldwide. One of the primary tools to slow the pandemic has been the widespread restriction on travel. Either through regional lockdown laws or by virtue of individuals taking extra precautions with their safety, travel opportunities have been severely limited since early 2020 and continue to be limited into late 2021. This drop in travel has had significant consequences for economies that depend on tourism, and cities such as Venice have felt the effects particularly strongly.

One organization working on this problem is SerenDPT, a benefit corporation dedicated to creating a more stable and sustainable economy in Venice. SerenDPT has partnered with SmartDest, a research project funded by the EU whose purpose is to find innovative ways to address the vulnerabilities in cities that have an overreliance on tourism. Their work is part of an initiative to assess the state of the Venetian economy and to develop creative solutions to improve it. One of the goals of SerenDPT is to quantify the cumulative impact of the COVID-19 pandemic on Venice so that action can be taken to reveal shortcomings in planning and help the city to monitor trends.

We aim to help SmartDest and SerenDPT achieve this initiative by compiling data into a single website that can provide clear visualization of trends - particularly in post-pandemic economy - for local governmental agencies, organizations, and concerned citizens. Therefore, the goal of our project is to improve the WPI Venice Retail and Hospitality website's capacity for collection, organization, and visualization of retail and hospitality data using semi-automated tools. To meet this goal, we will: 1. Compile and organize existing data on retail shops collected in recent years; 2. Collect data on the current state of the Venetian retail and hospitality sectors; and 3. Compare the state of the retail and hospitality sectors before and after COVID. At the close of our project, we expect that the 'Venice Shops' website will be improved to display and sort all of the shop data that has been collected through meaningful figures that help visualize trends in the economy.

Chapter 2: Literature Review

In order to understand our project in greater detail, this chapter breaks down trends in the Venetian retail and hospitality sectors, discusses how tourism has impacted the city historically, introduces major stakeholders, and describes the impact that COVID-19 has had on the city. We also examine a selection of case studies to better understand which data collection and analysis techniques work in a context similar to our own.

Figure 2.1: Tourists swarming Venice, Italy (Lewis, 2021)

2.1: The Italian and Venetian economies

To understand Venice, we first need to step back to look at the bigger economic condition in Italy. The country's economy is one of the strongest in Europe and it is the ninth largest in the world. Its service industry is the main pillar of the workforce, employing about 65% of the working population and making up almost three-quarters of the country's GDP (FocusEconomics, 2021). The next largest sector is the industrial sector which accounts for 30%

of the country's workforce and GDP, followed by agriculture which employs 4% of the workforce (FocusEconomics, 2021). The majority of the industrial sector is in northern Italy and the agricultural sector is found primarily in southern Italy.

Italy has been struggling to grow its GDP for the last few decades despite having one of the top economies in the world. Throughout the early 2000s the annual average growth of Italy's GDP was around 1.2%, but the country suffered a contraction of about 5.5% in 2009 (see Figure 2.2) (FocusEconomics, 2021).
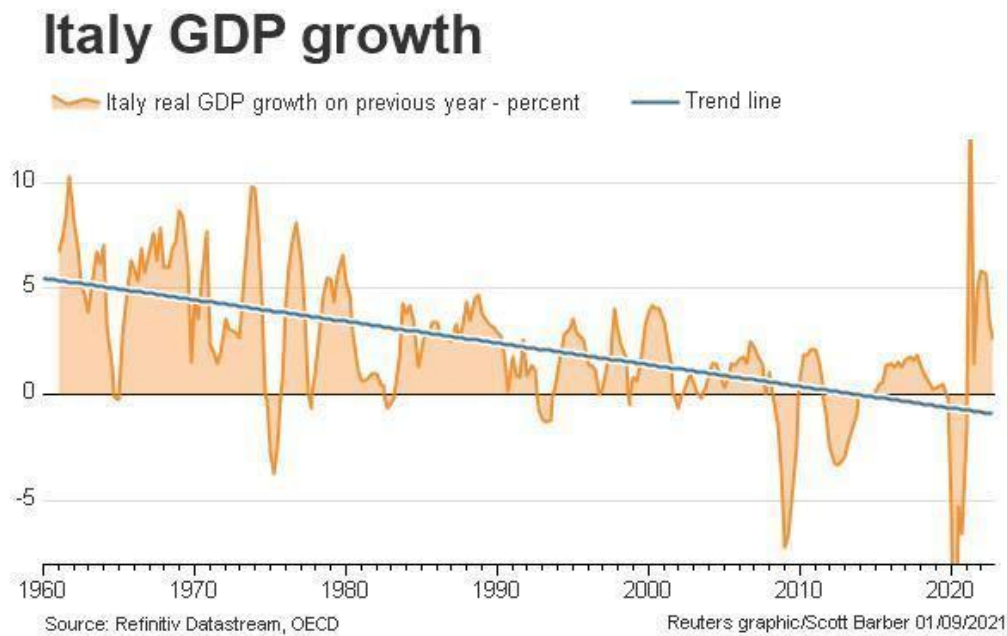
Figure 2.2: The figure above shows the GDP of Italy since 1960 (Barber, 2021)

The Italian unemployment rate has hovered around 10% for the past few decades, which is significantly above the European average of 7.6% (FocusEconomics, 2021). This unemployment rate stresses the need to further develop and expand the labor market to compete with growing competition around the globe. Within Italy, the city of Venice is a high value target for tourists visiting Italy with twenty to thirty million visitors annually. While the influx of consumers can be seen as a positive for growth, it has serious implications for quality of life for

local residents. The main Venetian island has roughly 60,000 residents, but the number was as high as 170,000 in 1950, as seen in the figure below (Economy & Politics, 2014).
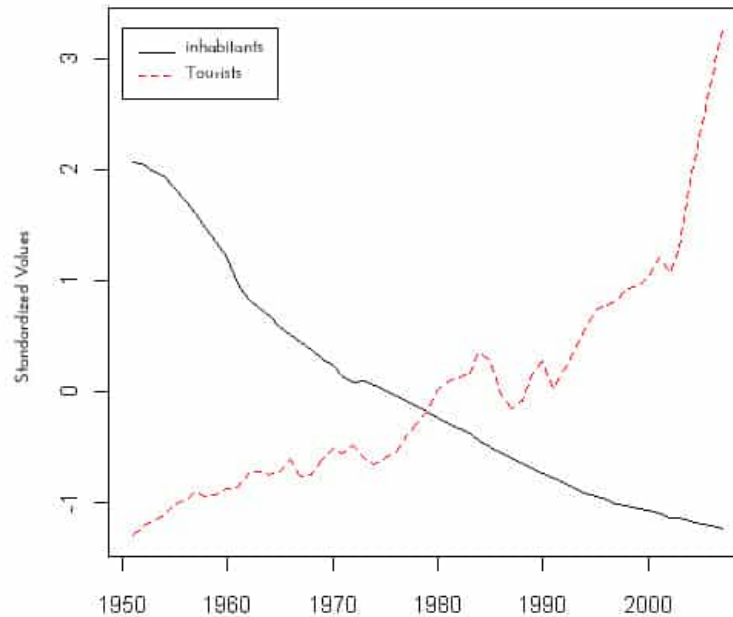
Figure 2.3: Venetian residential and tourist trends since 1950 (Venezia Autentica, 2019)

The number of full-time residents on the main islands has been steadily decreasing for the past 70 years due to the superior living and working conditions available on the mainland, for young people in particular (Economy & Politics, 2014). These trends have shifted the potential for new families and children to live in Venice and have essentially cut the population growth of permanent residents in the city.

2.2: Venetian tourism, retail, and hospitality

Venice has been strongly dependent on tourism for decades. The city draws roughly 2.3 billion Euros annually from tourism alone (Wingerter, 2015). It is estimated that before the COVID-19 pandemic, about 60,000 tourists visited the city each day, matching the number of residents in the city and doubling the population. This huge number of tourists has forced local retail to focus heavily on tourists. Many local shops have started to sell souvenirs to offset their

small incomes caused by the declining population. The scale of Venetian tourism has damaged the development of the city and alienated many residents for years, so recently, Venice has taken some steps to reduce this impact. A tax on tourists and a ban on cruise ships in the lagoon were recently introduced to combat the consequences of overtourism. The tax is expected to bring three to eight Euros per visitor depending on the time of year. This charge, however, does not apply to tourists staying the night in the city because they already paid a visitor tax (Warren, 2021). It is believed by some experts that this low fee will not deter tourists in any impactful way, but the city can nevertheless use the revenue generated to fund projects that support residents (see Figure 2.4, below).
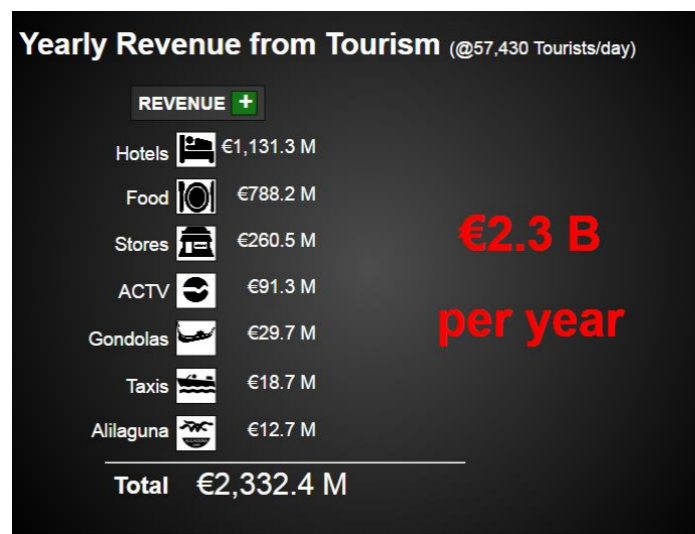
Figure 2.4: Breakdown of Venetian annual revenue from tourism (Blanco et al., 2014)

There are other reasons to rebalance the economy away from tourism. Residents of Venice complain that tourism has worsened their lives by making it much harder to get around. Furthermore, historic structures that have been standing for centuries are degrading at a much higher rate than they would if tourism was limited (Wingerter, 2015). Overtourism can lead to increased CO_2 emissions, increased waste and pollution in the city and the lagoon, and faster erosion of canal walls as there are a lot more boats needed to compensate for the tourist activity.

These problems cost the city approximately 30 million Euros a year, not counting the 45 million Euros budgeted to deal with the trash generated from tourists (Wingerter, 2015).

In addition, the scale of tourism has led to an explosion of Airbnb, which has quickly become one of the most important components of the Venetian hospitality sector. Airbnbs started popping up around the city to provide short-term lodging to tourists, and property owners quickly realized that renting out Airbnbs was much more profitable in the long run than dealing with long-term tenants (Buckley, 2021). This has contributed significantly to the lack of affordable housing, which is one of the main problems that has led to the expulsion of locals. Venice is among the Italian cities which have asked the Italian government to place restrictions on Airbnb as its influence continues to grow, and residents generally agree with this sentiment (Buckley, 2021).
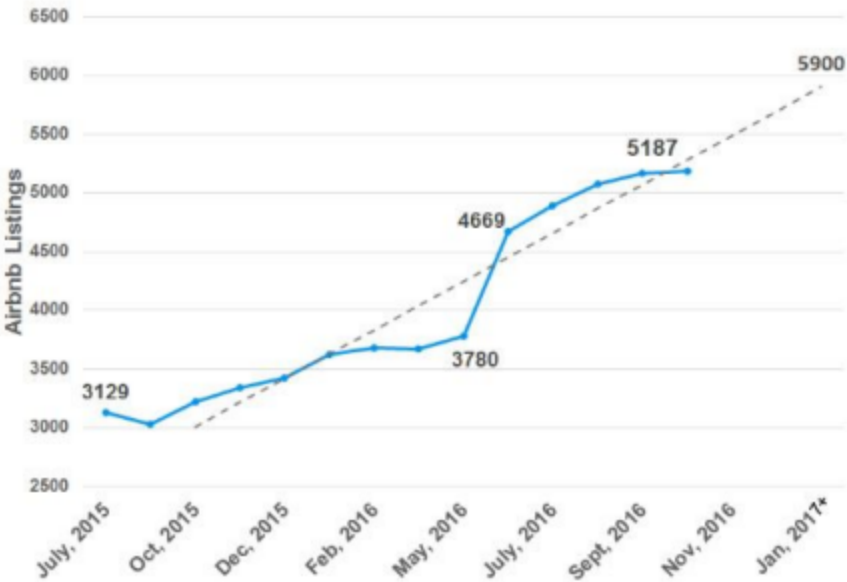

Figure 2.5: Venetian Airbnb numbers between 2015 and 2017, there are almost 9000 listings as of late 2021 (Boigenzahn et al., 2016)

The state of tourism in Venice is making it hard for the residents to live there, and as this effect continues more and more residents leave. Tourism has raised the price of property, food, and transportation, and jobs in the city that are not related to tourism are becoming scarce (Wingerter, 2015). City officials are beginning to combat this effect with some restrictions, but more can be done to combat overtourism and to bring back balance to the beautiful city.

2.3: The effect of COVID-19 on Venice

In December of 2019, the COVID-19 pandemic created an emergency that had significant repercussions around the world. Italy was the first European country to face the COVID-19 crisis, and it endured a traumatic death toll. As of late 2021, the country recorded more than 130,000 deaths from nearly 5 million total cases (World Health Organization, 2021). The fatality rate of Italy (2.814%) was well above the worldwide rate of 2.056% (Centers for Disease Control and Prevention, 2020).

After Italy's initial struggle to keep the virus at bay, they responded by implementing some of the strictest travel policies in the world. Italy only allowed vaccinated visitors into the country, and as of August 6, 2021, required a "Green Pass" to go out to dinner, the gym, or large events. At the start of the pandemic, Italy closed all non-essential businesses, leaving only grocery stores, pharmacies, public transportation, and postal services open. Production from factories was allowed to continue but serious precautions were put in place which decreased output (Belligoni, 2021).

The travel restrictions that came with COVID-19 highlighted Venice's vulnerability and its overreliance on tourism. The sudden halting of any tourists entering Venice left over 25,000 Venetians (whose livelihood is based on tourism) without a steady source of income. The sudden drop in tourism could cost the city more than 1 billion Euros in lost revenue (Warren, 2021). Although some struggling hotels and restaurants were provided with aid packages and tax breaks to help keep them afloat, many other sectors (e.g. tour guides) did not receive the same benefits and were forced to stop operating (Warren, 2021).

Figure 2.6: Empty tables in an Italian restaurant following COVID restrictions
(D'Emilio, 2020)

COVID has created a temporary pause in the number of visitors and brings a unique opportunity to assess the state of the local economy. The wealth of past data and the potential for present data collection provide the perfect foundation for us to better understand the extent to which Venice is dependent on tourism, and where progress can be made. Mapping these trends is critical to urban planning, and public resources hosting the trends will be a valuable resource to both policy makers and residents.

2.4: Project stakeholders

The main group who benefits from our work will be users (e.g. agencies, researchers, urban-planners) interested in overtourism. Our data will provide insight into how the major changes brought forth by COVID-19 exposed Venice's economic over-reliance on tourism. Our website will allow for users to quickly digest several years of data on retail and hospitality data and understand the associated trends.

SmartDest is a research project dedicated to analyzing the effects of over tourism in several European cities. It is one of several projects funded by EU Horizon 2020 - a financial implementation of a EURO 2020 initiative aimed at securing European competitiveness on the global stage (Kugleta, 2017). The project is pursuing research and development activities in the European cities of Lisbon, Amsterdam, Barcelona, Vienna, Ljubljana, Jerusalem, Turin, Edinburgh, and Venice. The post COVID tourism-related commerce sector in Venice is of great interest to SmartDest due to the potential exclusionary mobilities which resulted from the pandemic (SMARTDEST, 2020).

SerenDPT is a primary partner of SmartDest and is specifically in charge of the Venice case study. Its goal is to solve some of the city's problems in strategic areas, using methods that could be scaled up to use around the world. SerenDPT facilitates its problem-solving process by creating data-driven products backed by 30 years of ongoing research (SerenDPT). The idea is to provide researchers interested in over-tourism in Venice, with data that reflects baseline as well as new trends reflecting the COVID-19 pandemic.

The visualization of data on the website could also allow for key points in the data to be accessible for a range of uses in better city management and planning. Venice city officials attempting to curb the decline of the resident population will be able to utilize our data in order to understand and act upon the varying distributions of tourist vs. local focused retail and hospitality services. Governmental policies and urban planning will be rendered more accurate by including our data analysis into their decision making processes as we would serve as an independent source of information.

2.5: Leveraging data for urban solutions

A report titled *The economics of COVID-19 pandemic: A survey* analyzed the changes in the stock markets, the price of oil, exchange rates, and the changes in policies around the world (Padhan, 2021). Their findings determined that COVID caused an increase of unemployment, an increase in international transaction costs, a sharp decline in travel, and decreased demand for services requiring proximity between people. The trends set the foundation for policy

recommendations to build stronger economic regulations and supports. The study also provides us with important background information on the economic effect of COVID that may help us uncover interesting trends much more quickly.

This project will look at COVID's impact on a single community, but will indicate similar types of trends. Padhan (2021) implemented many useful techniques for measuring and displaying economic change including comparing important economic indicators and analyzing the stock market. They perform the bulk of their analysis in a simple but very effective way: comparing the numbers and trendlines of important figures just before COVID to the numbers and trendlines during and after COVID. These techniques are described in detail in the report, and while the information they produce is interesting, the textual descriptions were not nearly as effective as the visuals at driving home the most important takeaways as demonstrated by the figure below.
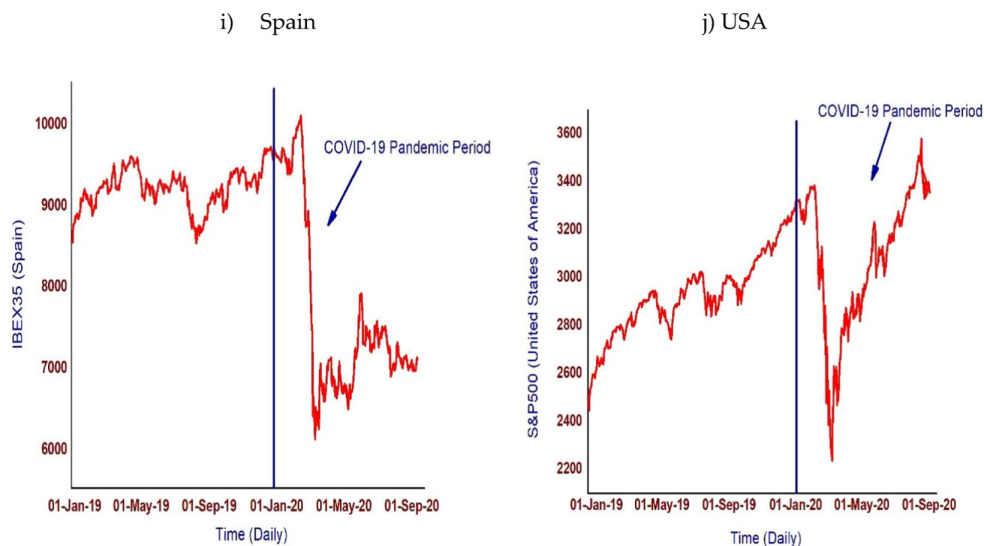

Figure 2.7: Time series of stock indices illustrating COVID's effect on world economies (Padhan, 2021)

As seen in the figures, the lockdowns and restrictions caused by COVID damaged both the Spanish and American economies severely, but while Spain continued to struggle in the

following months, America quickly bounced back. The graphic is easy to understand from a quick glance, does not require extensive reading or a technical background, and communicates the trends very effectively. The information is not particularly relevant to Venice or to our project, but we can learn the method in which it is presented. While an extensive written report with substantial in-depth analysis may also describe the trends we find accurately, it is not accessible to the general public or to busy policy members. To reach our target audience, we will utilize the clear visualization techniques learned from Pandan.

Another report titled *Data Science and Cities: A Critical Approach* outlined the numerous ways that data facilitates better and more efficient urban planning (Duarte, 2020). Data helps policy makers develop clear understandings of urban issues in a way that qualitative information cannot. Duarte (2020) explains that databases relating to a problem allow urban planners to uncover both the true causes and the true extent of the issue, which is essential for developing an effective solution. Trackable data can also provide evidence that change is needed. Providing useful databases helps support urban planners and policymakers. Our plan to collect and creatively express data trends can provide Venice with a resource for making change.

2.6: Learning from data collection approaches

We examined a similar case to learn more about data collection and analysis from teams on similar projects. The case, titled "Overtourism and the night-time economy: a case study of Budapest", was intended to research and analyze the effects of over tourism on the city of Budapest (Pinke-Sziva, 2021). The researchers focused on how the nightlife economy affects the city, tourists, local businesses, and local residents. They identified that tourism-dependent economies often breed social and financial problems, citing Venice among other tourist cities as an example of this phenomenon, and performed this study to quantify the concrete effect of tourism on the city of Budapest.

The research team used a survey to gather most of their data, and while surveys can be a useful and reliable data collection technique in some contexts, in this case study it seemed to

yield skewed results. They attempted to equally distribute the surveys among different sampling groups based on age to ensure the results were representative of the actual population, but after the data had been collected, they discovered that they were unsuccessful because the data they used to distribute the surveys to the groups had not been updated in recent years.

The researchers also went onsite to collect information about the city itself. They recorded information from local shops and bars, performed interviews with relevant residents, and observed interactions between locals and tourists. Although the data resulting from this collection method was used mostly to gain a better understanding of the setting so the questionnaires could be created, it ended up being the most usable data generated by the study. This tells us that observational data may be more accurate (and easier to collect) than data on public sentiment in this type of setting, and this lesson will help us build a stronger, more effective report.

While this case only produced limited deliverables, we also studied numerous cases in which data collected by researchers became a resource for policy makers. One such study, titled "Learning from overtourism; new tourism policy for the city of Rotterdam," chronicled the steps that policy members in Rotterdam took to combat overtourism between 2018 and 2020 (Nientied, 2020). In 2018, a new city government was elected in the municipality, and this government concluded that their vision of tourism needed to be reassessed. Through a synthesis of expert opinions and in-depth data analysis, the government came up with a new set of policies for dealing with tourism. Having readily available and reliable data was extremely important to the policy makers tasked with updating Rotterdam's vision for tourism, as it allowed them to quickly assess the condition of a large and complex city and provided evidence for the trends they were looking into (Nientied, 2020). The research group concluded that the policies were a step in the right direction, which points to the idea that good data collection and analysis can have concrete impacts on policy.

2.7: Summary

Venice has had a problem with overtourism for years, and the COVID pandemic brought the city's reliance on tourism to center stage. Our research showed us how dependent Venice is on tourists and that this fact means COVID hit the city particularly hard. Examining other case studies helped our group to identify which data collection techniques we will be using on our project. To present findings in a concise way through high quality graphics will enable good access and amplification of data for urban planners and policymakers in Venice.

Chapter 3: Background

Although the purpose and methodology of our project are unique, we are not the first Venice Project Center team to come to Venice to collect data on and analyze Venetian retail. Teams in 2004, 2005, 2009, 2010, 2011, 2012, 2015, and 2018 all came to the city with similar missions, and each of these projects provide interesting insight into the collection process and visualization processes that we were able to learn from and implement into our own project.

3.1: 2004 SHOPS team

The 2004 SHOPS team was the first team to work on a project involving the Venetian retail sector and how its connection to tourism can impact residential life. This team started data collection by cataloging all the stores in each sestieri. They were one of few SHOPS teams that reached each sestieri and collected a significant amount of data points. They chose to start in Castello (one of the six sestieri in Venice) and work their way through the streets systematically. They also chose to approximate restaurant seating numbers when possible. They prioritized data collection over interviews with locals, however when time allowed them to, they did conduct interviews. They made sure to take photographs of stores they collected as well, which many future teams chose not to do. This SHOPS team focused heavily on categorizing whether or not a store catered to tourists or residents or both. The team then used a map and created a layer that showed all the stores on the map and allowed access to the collected data. They used this to display what neighborhoods were residential or not to help them in their study.

3.2: 2005 SHOPS team

The 2005 SHOPS team noted that they planned to simply focus on shops that fit the category of a basic necessity. They chose this to ensure that in the time frame they had available to them they would be able to collect as much relevant data as possible. They were able to utilize the shop data collected by the 2004 team and build a dataset that they were able to add their own

collected data into. The team then went into the field and noted any store closures, any new stores of interest, or changes in store types. A unique tactic they used was bringing along a translator with them in the field and questioning residents of the area about the history of the shops around the area and how they have changed over the years. They created a B.N.A.I database (Basic Necessities Acquisition Index) after data collection that allowed them to determine availability of basic necessity stores in each sestieri and compare them to the rest of the sestieri

3.3: 2009 SHOPS team

The 2009 SHOPS team used a survey when going around the city and collecting data. They systematically walked through sestieri following the numbers on buildings as buildings in Venice are numbered monotonically, beginning with 1, and proceeding through the highest number of each sestieri. Rather than focus solely on basic necessities stores, this team focused on retail related services. This team spent their time at each store location analyzing specific attributes of the location. They looked at depth, merchandise sold, height of lowest merchandise, etc. They focused on these specific attributes due to them wanting to analyze how big of a loss the store would take if a flood occurred. When they moved onto the restaurant sector they looked specifically at whether or not the restaurant had indoor or outdoor dining and estimated how many seats they had to estimate income. The team also took quick data on the hotel sector but not much in-depth information. The group then shifted their research to a small area and focused on collecting shop data and fitting them into categories to find trends in the retail sector. They did this with a notebook and pencil rather than entering information into a database or an application.

3.4: 2010 SHOPS team

The 2010 SHOPS team focused only on the retail sector in Venice. They planned to focus on three specific sestieri for data collection; Santa Croce, San Polo, and Dorsoduro. This team used a new coding system called the N.A.C.E (Nomenclature of Economic Activities) system. This system has a specific coding for stores and their specific type of merchandise. They split

into two teams of two and started collecting data in the same sestieri. One team starting at building #1 and the other starting at the last known building number and collecting data until both teams join together again. The team collected the information using a field form they created. This form required the store name, address, type of merchandise, current state, and the date of the day data was being collected. They then used the data that the 2004 team collected and combined it with the data that the 2009 team collected into one database. If the same stores were collected in both years, the two data points were merged into one single point to allow for data analysis while also keeping it known that the data was collected in two different years. This was the first team to create an interactive map that displayed the information collected.

3.5: 2011 SHOPS team

The 2011 SHOPS team used a simple field form to collect data. They focused only on castello as the past groups did not get to it since 2004. The group said that they were able to get to 879 stores and of those stores 214 were closed. This team used the sorted list of stores that the 2010 group made to categorize the new stores being collected to be put into the database for analysis. This team put data into a website they built that was interactive as well. It was possible to see each storefront from the map. The website contained information from all past stores. The team then used this website to help them with their data analysis. They were able to find some interesting trends among the retail sector in castello.

3.6: 2012 SHOPS team

Rather than starting off thinking about ways to collect and add data to a database, the 2012 team used census data released by the Italian National Institute of Statistics. They used the data to obtain information on population density and tracked the change in population using census data from 1991 and 2001. To study tourism, the team got data released by the Comune di Venezia. The team then used the NACE system as well, however they modified it to be even more specific. The NACE code has four components to classify a store and they added a fifth component to further classify stores. Utilizing the website created by the 2011 team, the group was able to put their reclassified data points onto the interactive map. They used a finer analysis

thanks to the new NACE system they created which showed a better view of the Venetian retail and hospitality sectors. After this analysis the team then went into the field and started data collection, being the first team to take pictures of the stores to add into the database.

3.7: 2015 SHOPS team

The 2015 SHOPS team focused first on creating applications that would help with quick data collection when in Venice. They first developed a mobile application titled the "Negozi App" and this was meant to optimize data collection time. The second application the team wanted to create was an application that would instantaneously display the information collected on the Negozi app and the data they received from the Chamber of Commerce; the first time the Chamber of Commerce released data to the Venice Project Center. After those applications were completed the team went into the field and started collecting data in Cannaregio. They marked down attributes of stores similar to past teams and then sorted the stores into whether they were tourist centered, residential centered, or mixed. To do so the team stood outside each shop they went to for a couple of minutes and documented the people that went in to decide what group the store catered to.

3.8: 2018 SHOPS team

The 2018 team first started off by looking at past data collected by the SHOPS teams before them. They intended to focus specifically on restaurants and hotels like some groups in the past since they have the biggest chance to change or remain the same over the years. The team then chose specific locations to collect data to be able to compare to that of past teams. Like the team in 2012 this group also chose to add additional extensions to the NACE code that already existed to further categorize stores they collected.

Chapter 4: Methodology

The goal of our project is to develop a web application for the standardized collection, organization and visualization of retail and hospitality data using semi-automated instruments. The updated website allows Venetian residents and policymakers (and any other interested parties) to better understand the direct effects of COVID-19 on Venice's tourist economy and to recognize associated trends. We achieved our project goal by completing the following objectives:

1. Compile and organize existing data on retail shops collected in recent years to establish a baseline for comparison

2. Collect data on the current state of the Venetian retail and hospitality sectors

3. Compare the state of the retail and hospitality sectors before and after COVID

In this chapter we discuss the process of completing the objectives in detail.

4.1: Compile and organize existing data on retail shops collected in recent years

Since 2004, Venice Project Center groups of the past have collected data from shops, resulting in almost two decades of data on Venice's retail and hospitality sector. These data sets recorded a similar set of features, facilitating interesting analysis, but were all decentralized, making this analysis impossible. The 2020 SHOPS team laid the groundwork for the consolidation of this data by combing through the project files of each team that collected data, but to create a single, workable database, we needed to synthesize the datasets they produced. The 2020 group produced one dataset listing all the locations that have been collected since 2004 and another listing every individual data entry made by every SHOPS team, so to begin the process of compiling the existing data, we created one centralized dataset with every location, in which each location contains all the necessary information about every entry associated with it.

The information associated with a location includes a unique ID number, the latitude and longitude, the street address, the sestiere in which it is located, the address number, and the complete set of entries that have been recorded for that location. The information associated with an entry includes the ID of the location, which was used to map the locations to the entries, the name of the store at the time of collection, the type of the store, the year the entry was recorded, and a link to a picture of the storefront.

Additionally, businesses are attributed a NACE code for a more precise classification. NACE (Nomenclature of Economic Activities) is the European standard statistical classification of economic activities. The NACE code consists of a series of four digits: first two digits of the code identify the division, the third digit identifies the group, and the fourth digit identifies the class. Utilizing a NACE code system to help classify businesses allows for our data set to remain compatible across a larger European classification standard.

While the datasets compiled by the 2020 SHOPS team represented an effort to identify all previously collected SHOPS data, there were two major aspects of the previous data missing from their results. The first was the data collected by the 2019 shops team. The short time between the 2019 SHOPS project and the 2020 SHOPS project presents one possible reason why this inconsistency occurred, but the 2019 data is an essential part of the story in Venice and must not be forgotten. The second missing component was links to the images taken by previous teams. While the data compiled by the 2020 team was decentralized enough to make its compilation impressive in and of itself, the images associated with all that data are even more scattered throughout project files. The team made an effort to find the images and were able to find a considerable number of them; they were not integrated into their datasets.

Rather than prioritizing the solving of these two data-related issues, we focused on producing a tool to house the database. While the dataset was still usable in terms of finding trends without the 2019 data and the images, it would be very difficult to analyze the data and almost impossible to visualize the data without a working application. The idea of an application to house 'shops' data is not new, every team since 2004 has produced some form of tool for visualizing the data they collected on a map of Venice, but none of the previously developed

projects properly served our goal. We needed a way to organize and display all the previously collected data by every team, and all of the previous applications were either inaccessible, no longer functional, or not properly suited for housing and visualizing multiple years' worth of data.
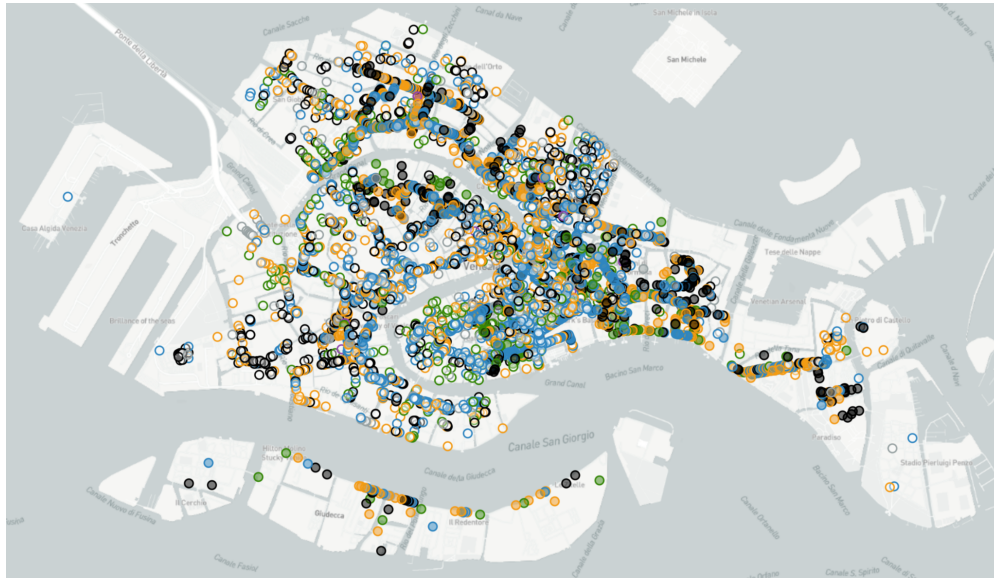

Figure 4.1: Our application displaying an comprehensive and organized set of all past Venice shops data

Before our arrival on site, we successfully produced a web application capable of displaying the locations of all recorded shops in Venice (see Figure 4.1). Each location is represented by a dot on a map of the city, and this corresponds to about 7000 dots. When clicked, each dot produces a popup displaying important information about each entry for that location (see Figure 4.2). The popup includes the year the entry was recorded, the name of the store at the time of the recording if applicable, the address, the type of the store, and buttons to scroll through the past and previous entries for that location if they exist. The popup also includes space for a picture of the location, but as images are yet to be integrated into the dataset, the image box is empty for all past data.
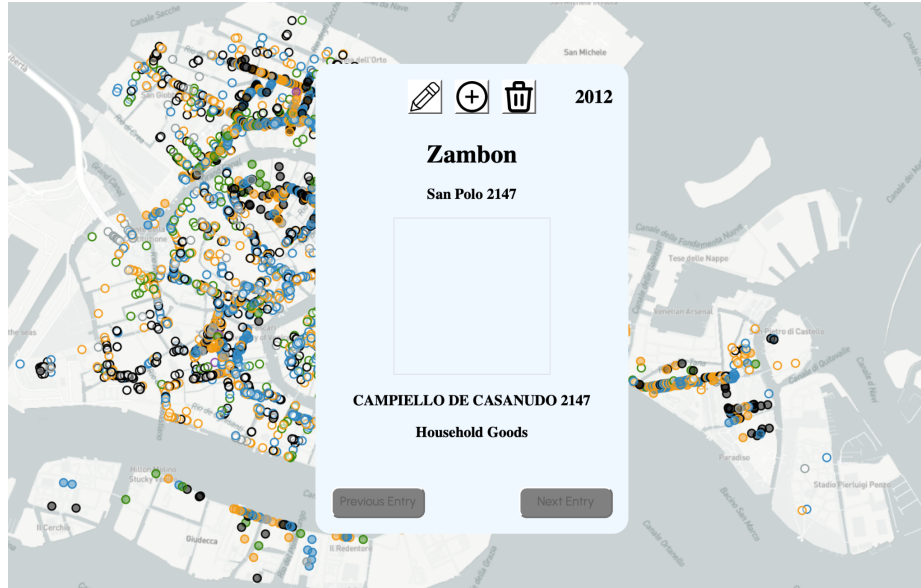
Figure 4.2: Popup for a sample location

Because future teams will not have to spend time developing a visualization tool, we advise that they dedicate part of this time to integrating the 2019 data and the previously collected images into the dataset. Our vision for the application was that it be the last version of the SHOPS tool, meaning no future team would have to develop their own website from scratch. They will be able to focus on more extensive data collection and more in-depth analysis with the extra time and functionality at their disposal. Creating an application capable of housing and displaying multiple years' worth of data was the first step of this process, but to make the tool completely maintainable and enduring, it needed to be capable of handling new data as well.

4.2: Collect data on the current state of the Venetian retail and hospitality sector

Our group had the opportunity to return to Venice to collect data in-person after more than a year of restricted travel from the COVID-19 pandemic. During this time, we collected a sample of retail and hospitality data from five of the six *Sestieri* in Venice as well as the island of Giudecca, a task that resulted in the categorization of 2354 individual businesses. Each previous

SHOPS team has collected data from only a selection of regions with the exception of the 2010 team, but we decided to get a sample from as many regions as possible to facilitate a more complete analysis. We had hoped to be the first team to collect data on every store in Venice, but application development time, a smaller than average team, and COVID quarantines made this an impossibility. Our primary focus was covering districts in Venice that have already been surveyed extensively by past groups, ensuring that shop data can be compared pre and post COVID.

Figure 4.3: Process of adding a new entry to an existing location

The data collection process itself was made quick, easy, and consistent through additional features in our application. When entering data, there are two possible scenarios: you come across a store whose location is already stored in the database, or you come across a store that no previous group has encountered. When entering a store whose location already exists, the process is straightforward: simply click the location, click the 'plus' button at the top of the popup, enter a new picture, leave the name and type fields the same if nothing has changed or modify them otherwise, flag it and add a note if it requires further review, and submit the new entry. The entry will automatically be entered into the database and be associated with the correct location, making it visible to anyone who clicks on the same location in the future (see Figure 4.3).
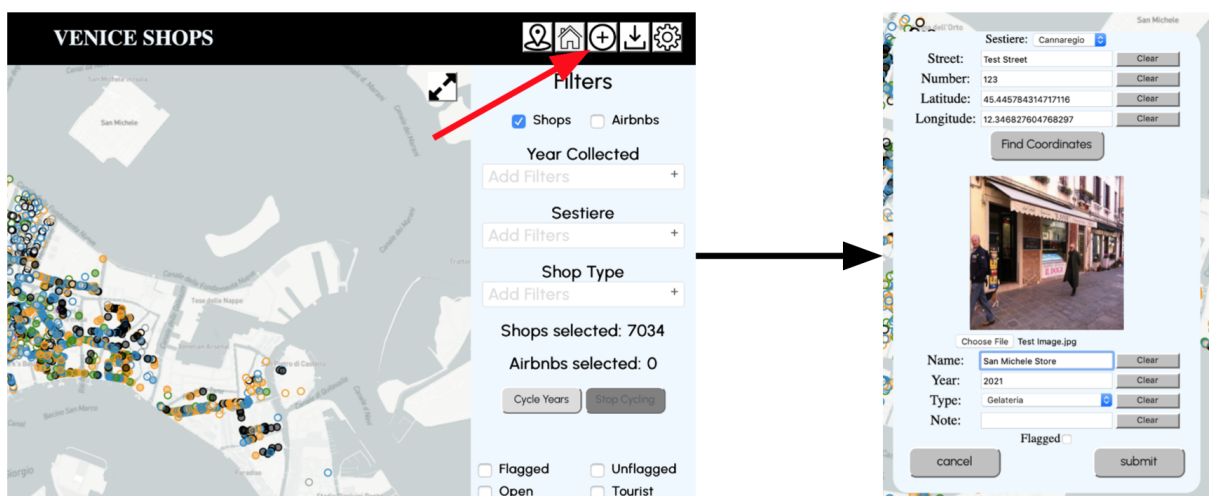
Figure 4.4: Process of adding a new location

When submitting an entry for a store that has not previously been collected, the process has a few more steps, but is equally as straightforward. The 'plus' button in the top-right corner of the application opens the 'new location' popup, which includes spaces to input the street name, sestiere name, number, and coordinates (which can be determined by clicking the appropriate location on the map after selecting the 'find coordinates' option) of the location in question. These options will be combined to form a new location in the database, and this

location will be associated with an entry with properties determined by the popup's image input, store name input, year collected, and store type input (see Figure 4.4). The entry can also be flagged for later review, a process that speeds up data collection in the field and ensures that unsatisfying or dubious data never gets entered and forgotten about. The mechanisms of these features, information on additional features, and instructions for maintaining and updating the application can be found in Appendix C.

4.3: Compare the state of the retail and hospitality sectors before and after COVID

Analysis of the retail and hospitality data took place as soon as the final data set (past plus current data) was completed. Once in-field data collection was completed at the later stages of the project term, our data was compared to data collected pre-pandemic and conclusions were drawn. Formatting raw data into Excel spreadsheets allowed for trend lines and regression models to be calculated. Comparing attributes such as years of service, type of shop, and target consumers over a span of years will allow for the effects of COVID-19 on Venice's economy to be quantified. We hope to display sets of trend data in a separate web application.

Using visualization tools such as Flourish and Infogram, data is being compiled into accessible and clear charts, graphs, and tables. These tools enabled our group's production of most of these visuals. We want viewers to be able to understand the message of our data visuals and be able to use them as evidence that the retail and hospitality sectors are shifting because of the COVID-19 pandemic. We predict that these shifts will point to some instabilities in the Venetian economy, and hope our visuals will convincingly show that Venice relies too heavily on tourism and that more sustainable systems for tourism should be implemented.

Chapter 5: Results and Analysis

       This chapter will be discussing the patterns discovered in the amount of stores, changes in stores and closings in each year of data collection. The first section of this chapter will be comparing the types of stores in each sestiere from each year to see if there is a pattern of any sort of change or consistency in the stores in the sestiere. The second section in this chapter will be going over the number of open and close stores in the sestiere of Cannaregio every year that the sestiere was collected. We decided to look into Cannaregio for this because data has been collected on the sestiere all but one year, 2011, so with this conclusions can be easily made on the health of the retail sector of Cannaregio by the samples collected. The third section of the chapter will be discussing the possible resurgence of bars in the historical city of Venice. It is believed that over the last decade or so the number of bars in the historical city have grown back towards the numbers that they once had in the 2000s. The fourth section of the results and analysis chapter is about the stores that changed from the previous year's entry.

5.1: Comparing the years

2004
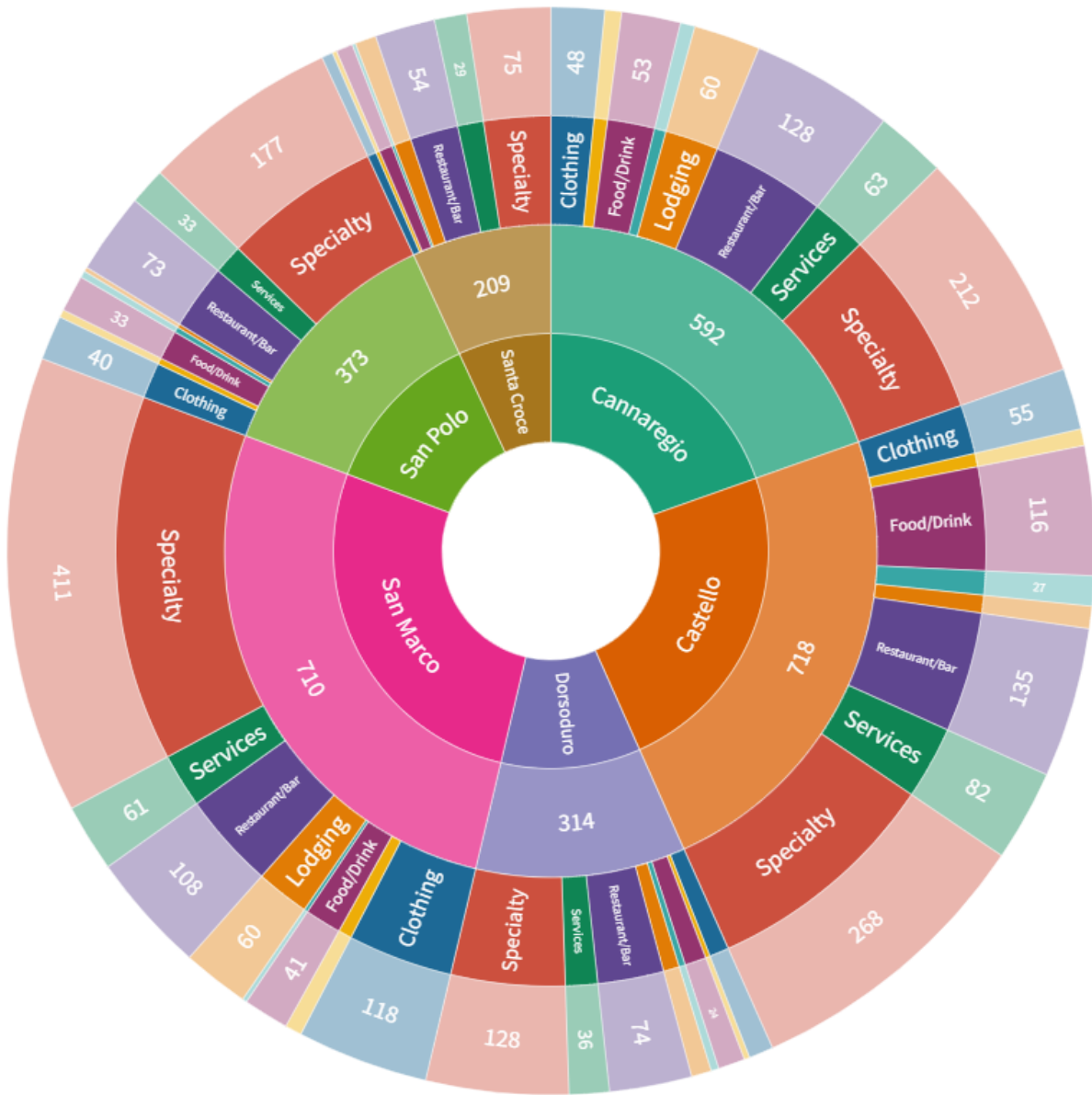

Figure 5.1: 2004 data breakdown

2005

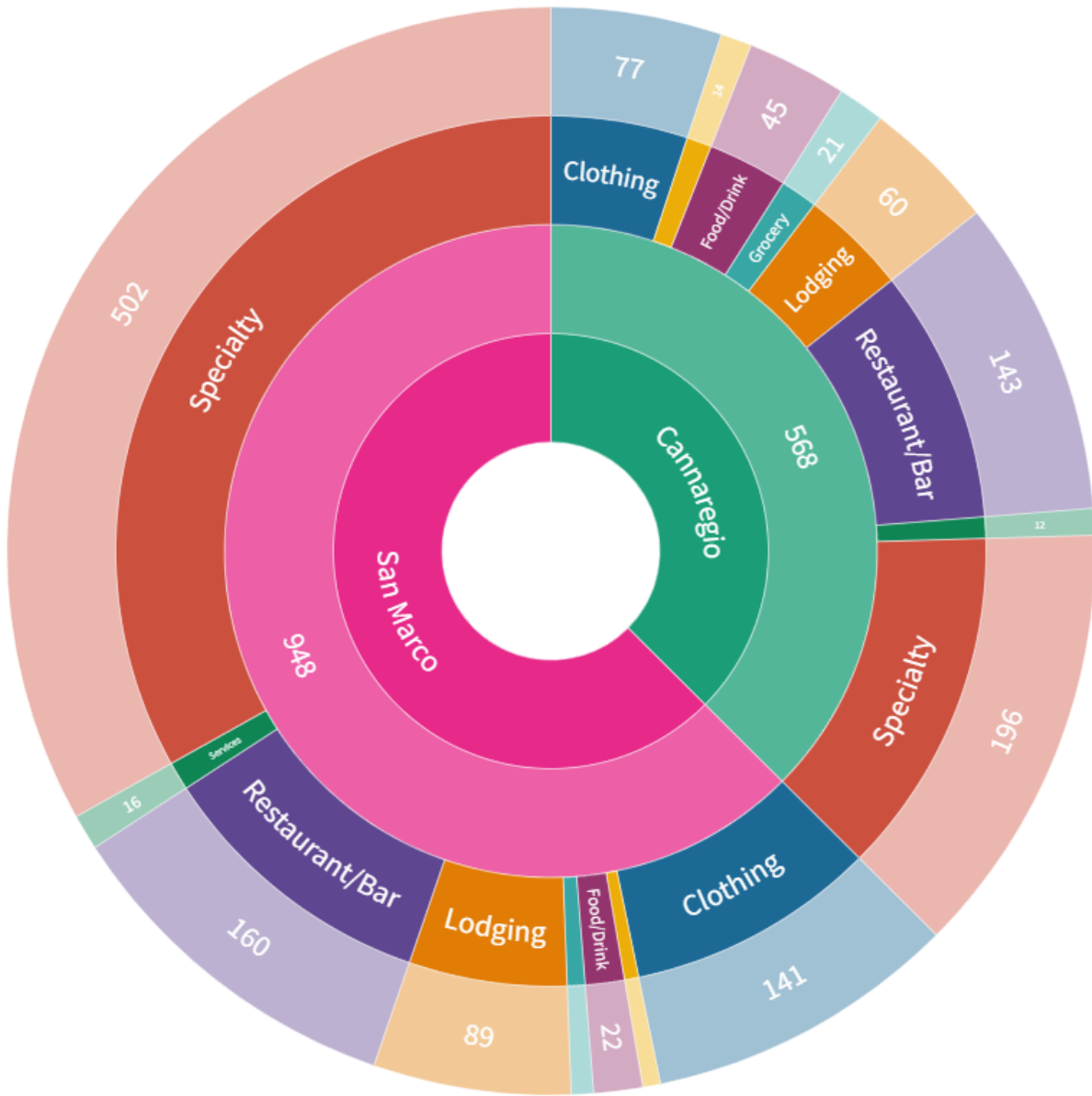Figure 5.2: 2005 data breakdown

2009

Figure 5.2: 2009 data breakdown

2010

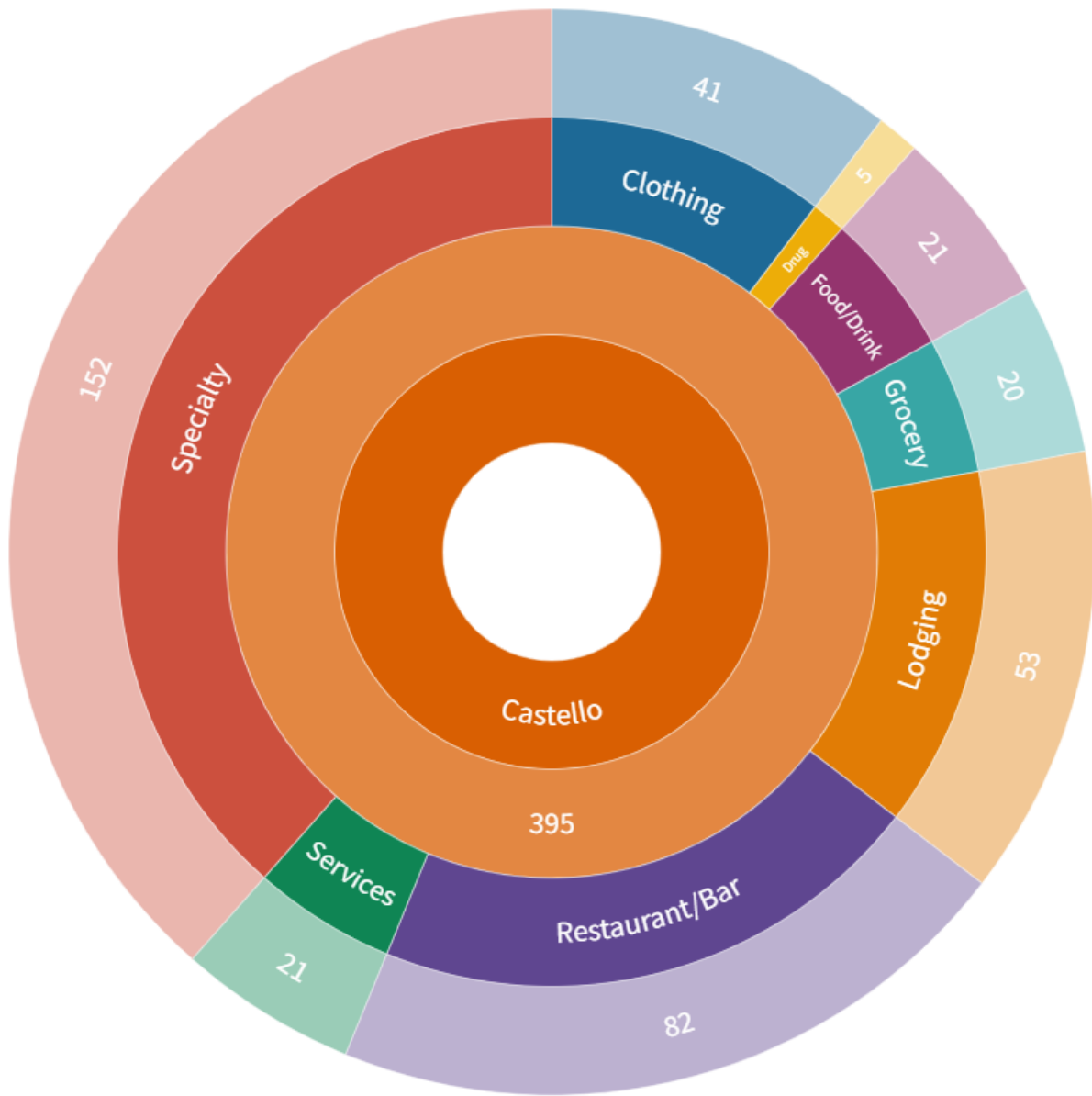Figure 5.4: 2010 data breakdown

2011
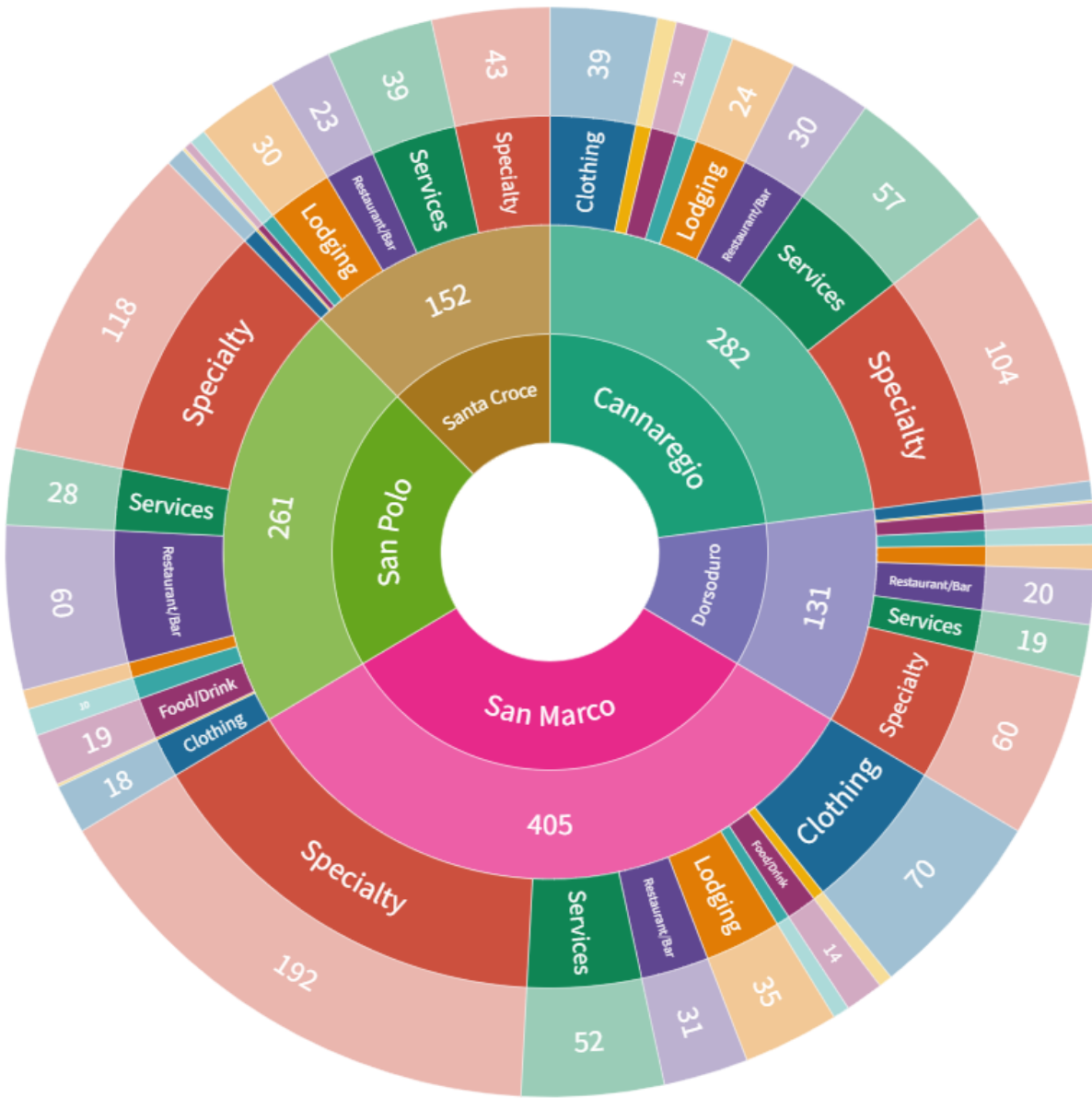

Figure 5.5: 2011 data breakdown

2012

Figure 5.6: 2012 data breakdown

2015
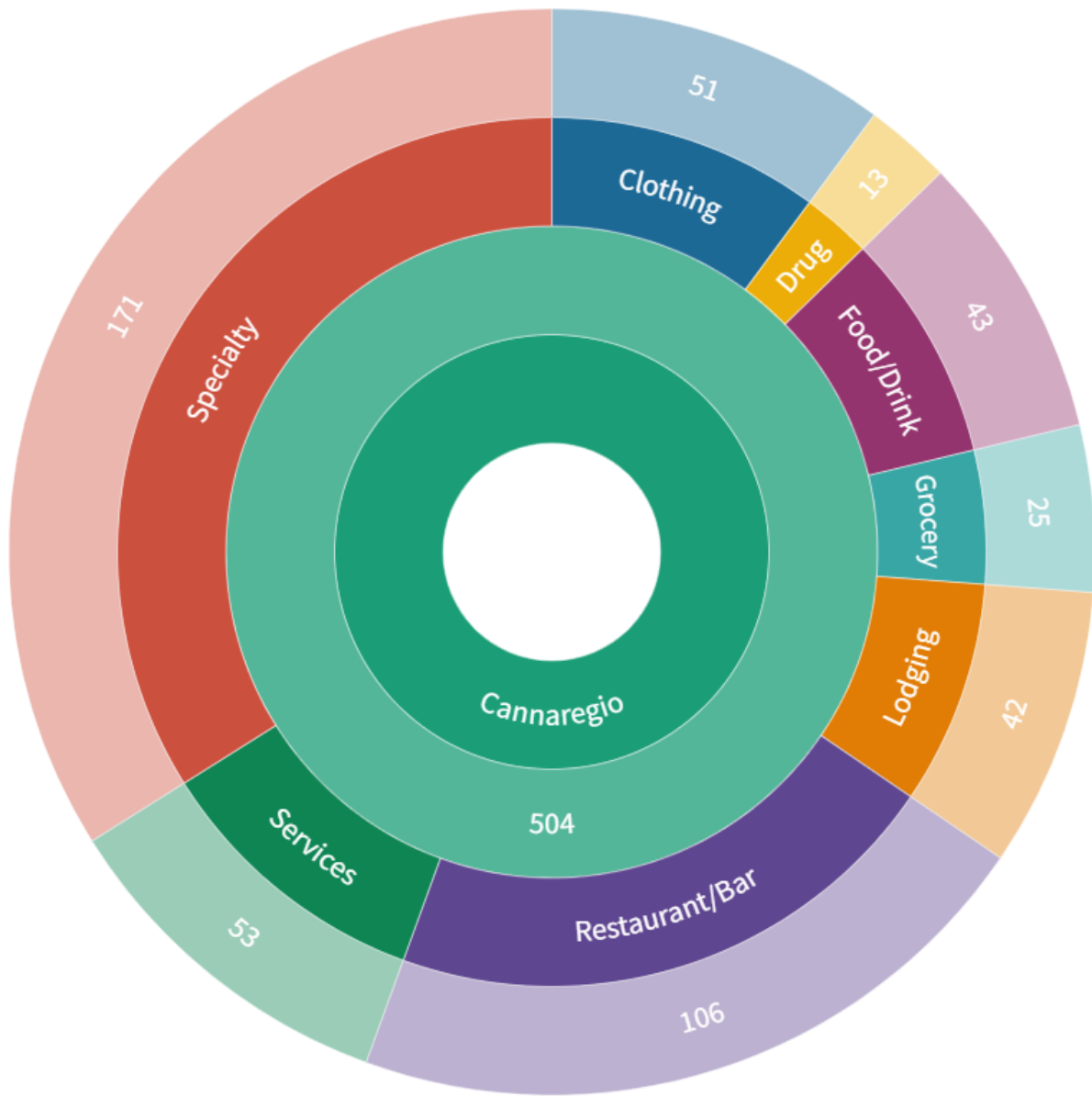
Figure 5.7: 2015 data breakdown

2018
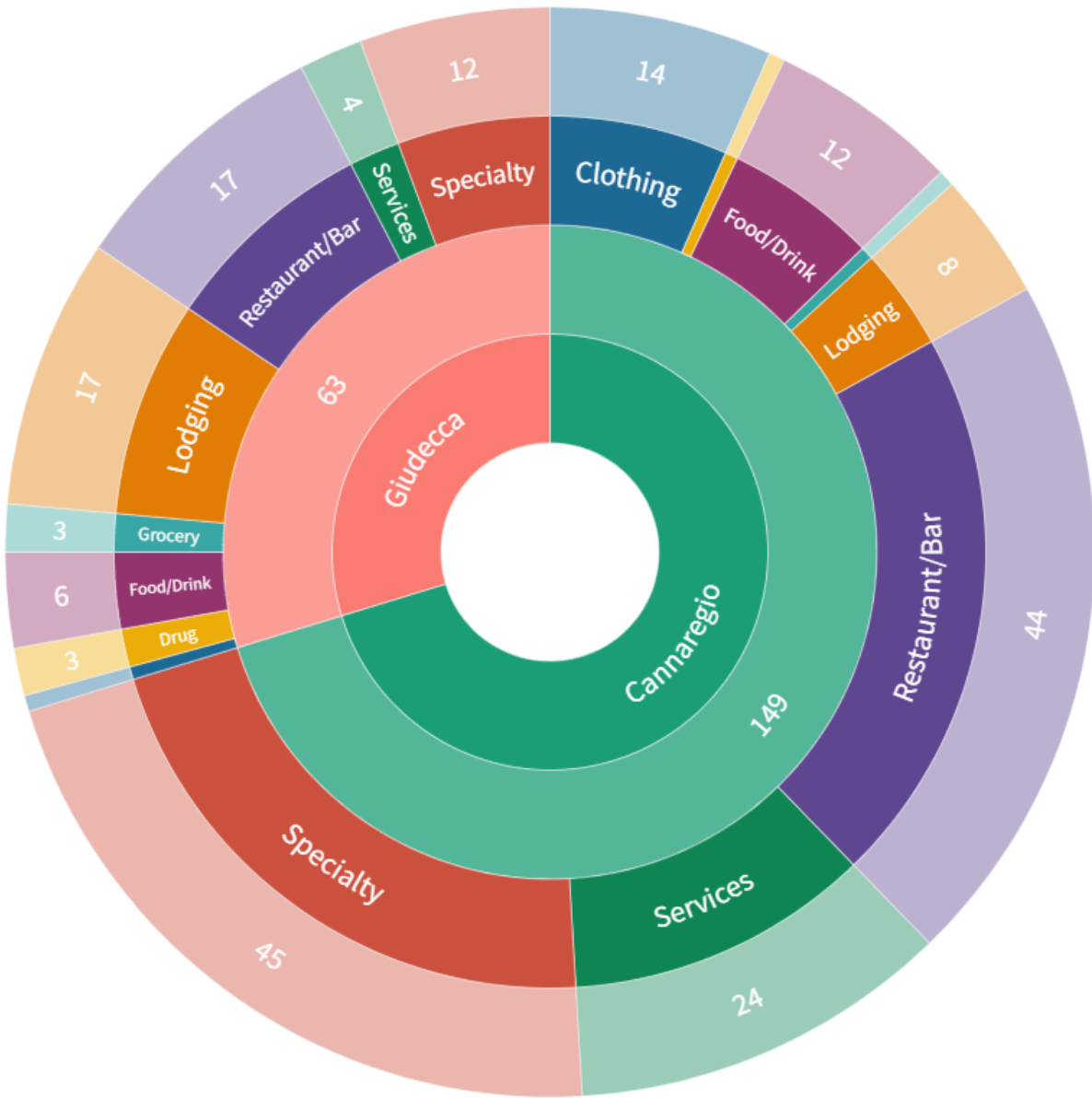
Figure 5.8: 2018 data breakdown

2021
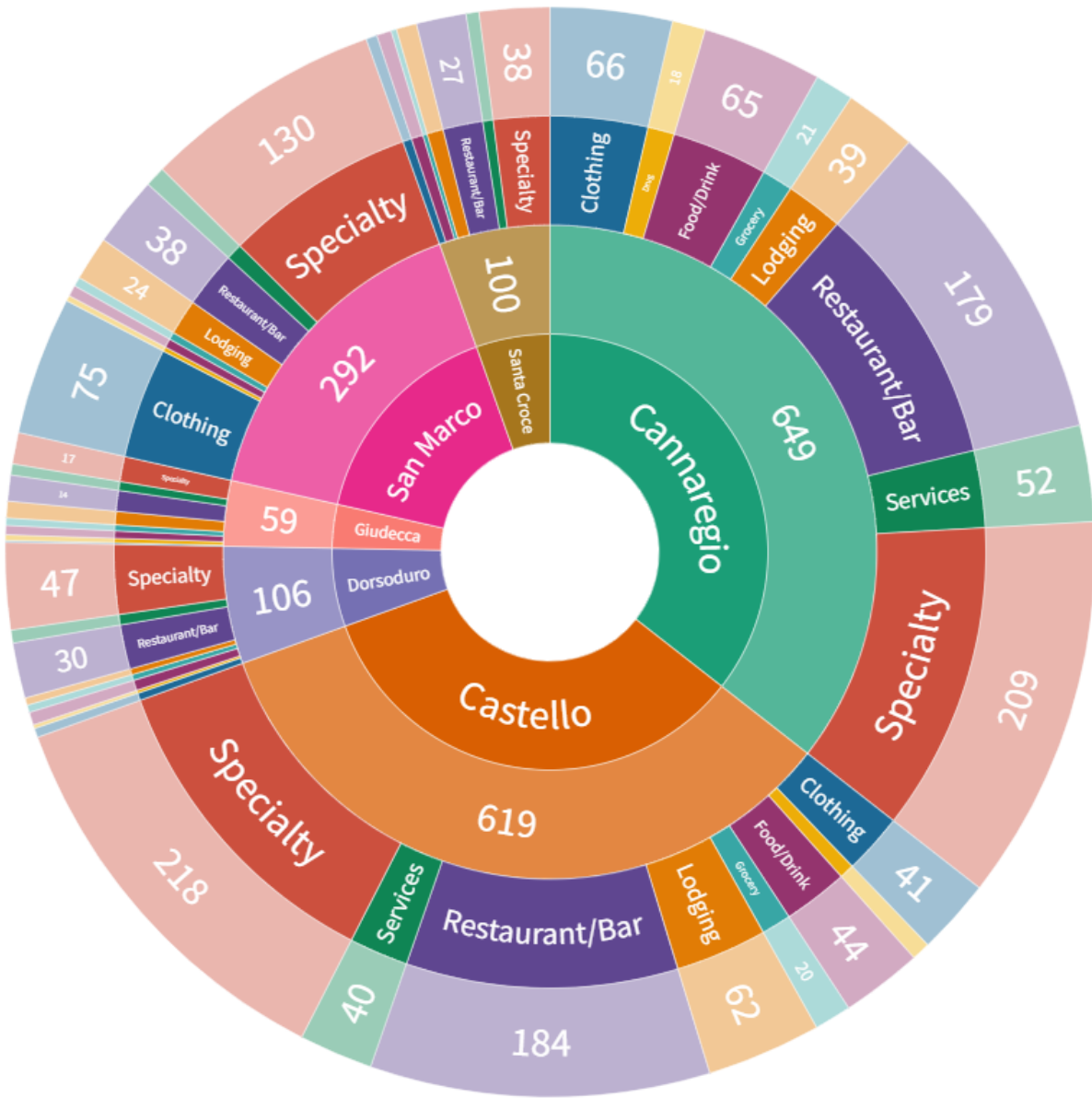
Figure 5.9: 2021 data breakdown

The graphics above show the breakdown of all open stores collected from 2004-2021 into eight major categories that we have on our application (excludes the entertainment category and the other category). The innermost ring is the sestiere, followed by the number of open stores in the next ring. Then it breaks the stores into their respective categories, clothing, drug, food/drink, grocery, lodging, restaurant/bar, services, and specialty. Finally, the outermost ring is the total number of stores that are in each category.

When looking at the graphics for each year it is clear without even knowing where in the historical city the sestiere is, how much it focuses on tourists as a source of business. The sestiere of Cannaregio, San Marco and San Polo appear to be the big three of tourist locations in the city. San Marco has the San Marco square with the Basilica and Doge's Palace, San Polo and San Marco also share the Rialto Bridge and then Cannaregio benefits by being a neighbor to the Rialto Bridge, along with containing a long street that starts at the bus station and runs all the way to San Marco and also splits off to Castello. These three sestiere show much higher totals of clothing stores than any of the other three sestiere and the Giudecca, appealing to tourists and their desire to buy clothing from a place they are visiting.

5.2: Cannaregio through the years open vs. closed
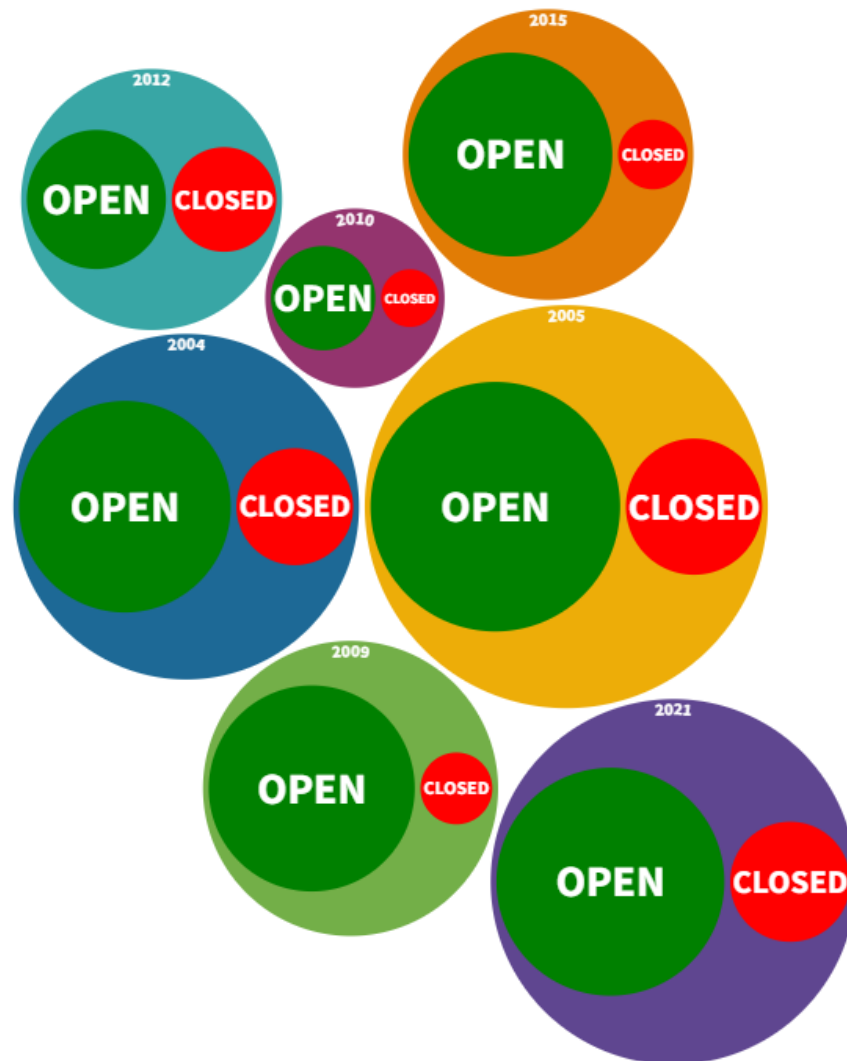
Figure 5.10: Cannaregio open vs. closed for all years except 2018

The graphic above displays the relative number of stores collected in Cannaregio that are open versus closed in each year that Cannaregio was collected. 2018 was left out of the graphic because it was heavily skewed in favor of open (140) to the total of closed (3). In this graphic it

is also noticed that in the two years Cannaregio was collected when the world and Italian economies were still down from the collapse of 2008 the total of closed stores was approaching the total of open stores in the sestiere. There was also an increase in the percentage of closed stores in 2021 than there were in 2015, which is an effect from the global COVID-19 pandemic.

5.3: Are bars making a comeback?

Size by:

Number of Bars ▼

2004
171

2005
142

2009
45

2010
36

2011
13

2012
55

2015
23

2018
10

2021
97
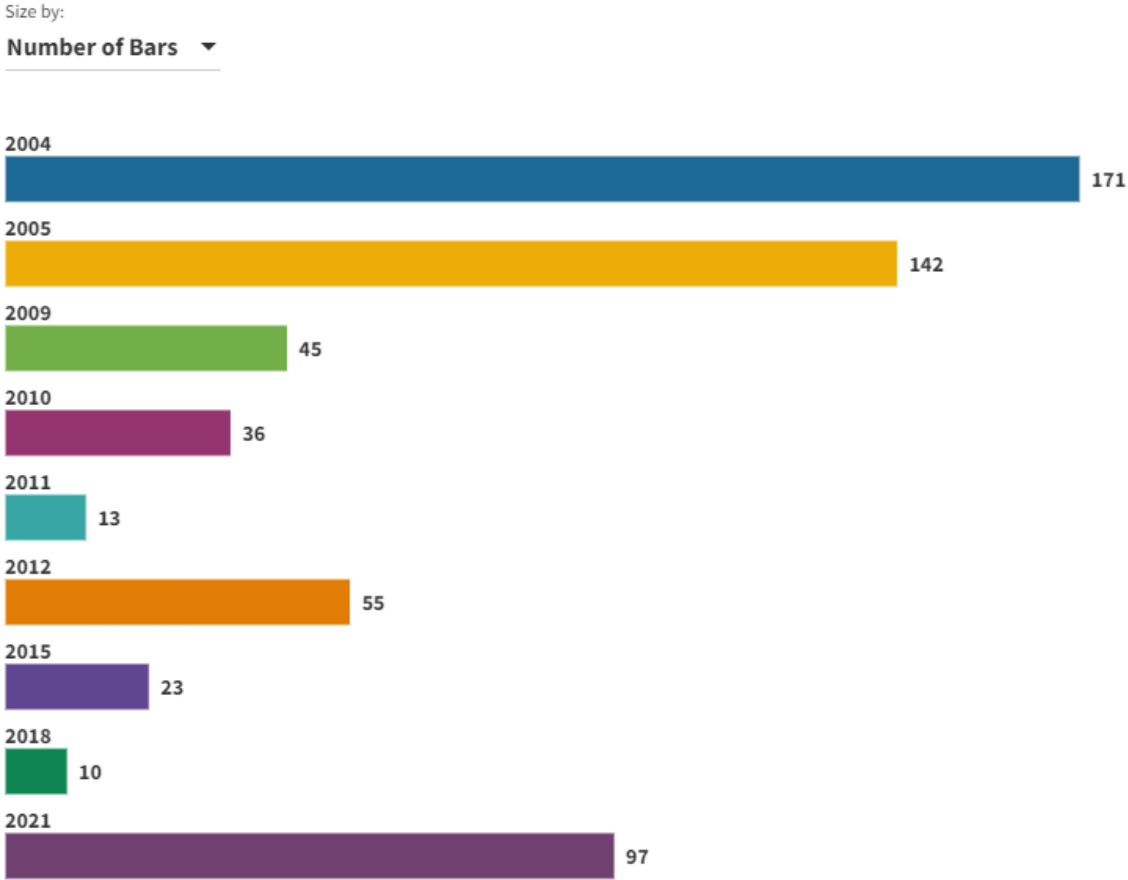
Figure 5.11: Total bars collected in all nine years
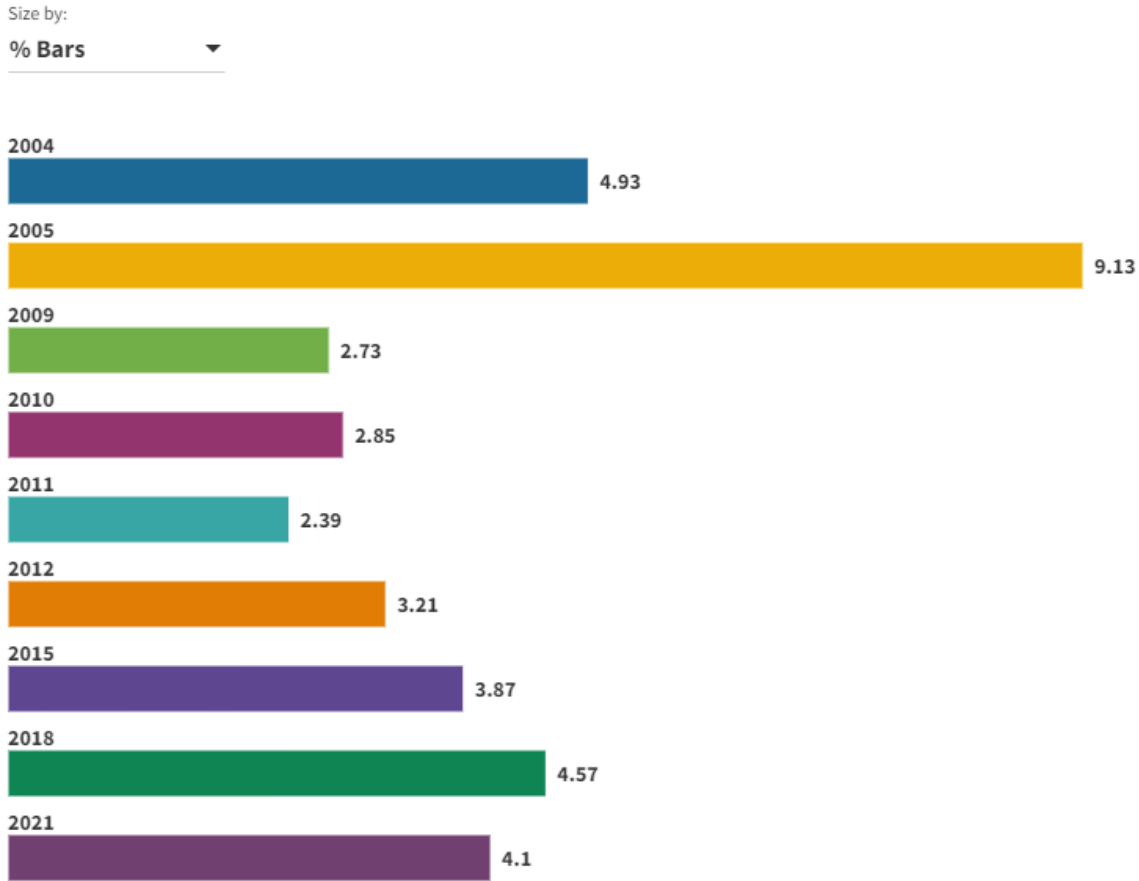
Figure 5.12: The percentage of all stores collected that are bars

The previous two graphics show the total bars collected each year and then the percentage of the stores that are bars. It was believed that bars have been increasing within the last decade or so in the historical city. With this thought we looked into the data collected from 2004 and noticed that the bar counts were much higher in 2004 and 2005, then with the 2008 economic collapse bars began to close, with not nearly as many tourists traveling from around the world to keep them in business. Then in 2012 the bars seemed to be recovering and, on the climb, but then turned around in 2015 and 2018. This is to be believed that in these years the data collected did not have a high enough number of stores to show an increase, that is why we look at the percentage of bars in the total and see that bars were likely still increasing in numbers. Then in 2021 the total of bars is much higher than the totals since 2009, but on the other hand it

appears that bars did take a bit of a hit from the global pandemic in 2020 to cause closings and a decrease in the bar percentage.

5.4: Change over the years
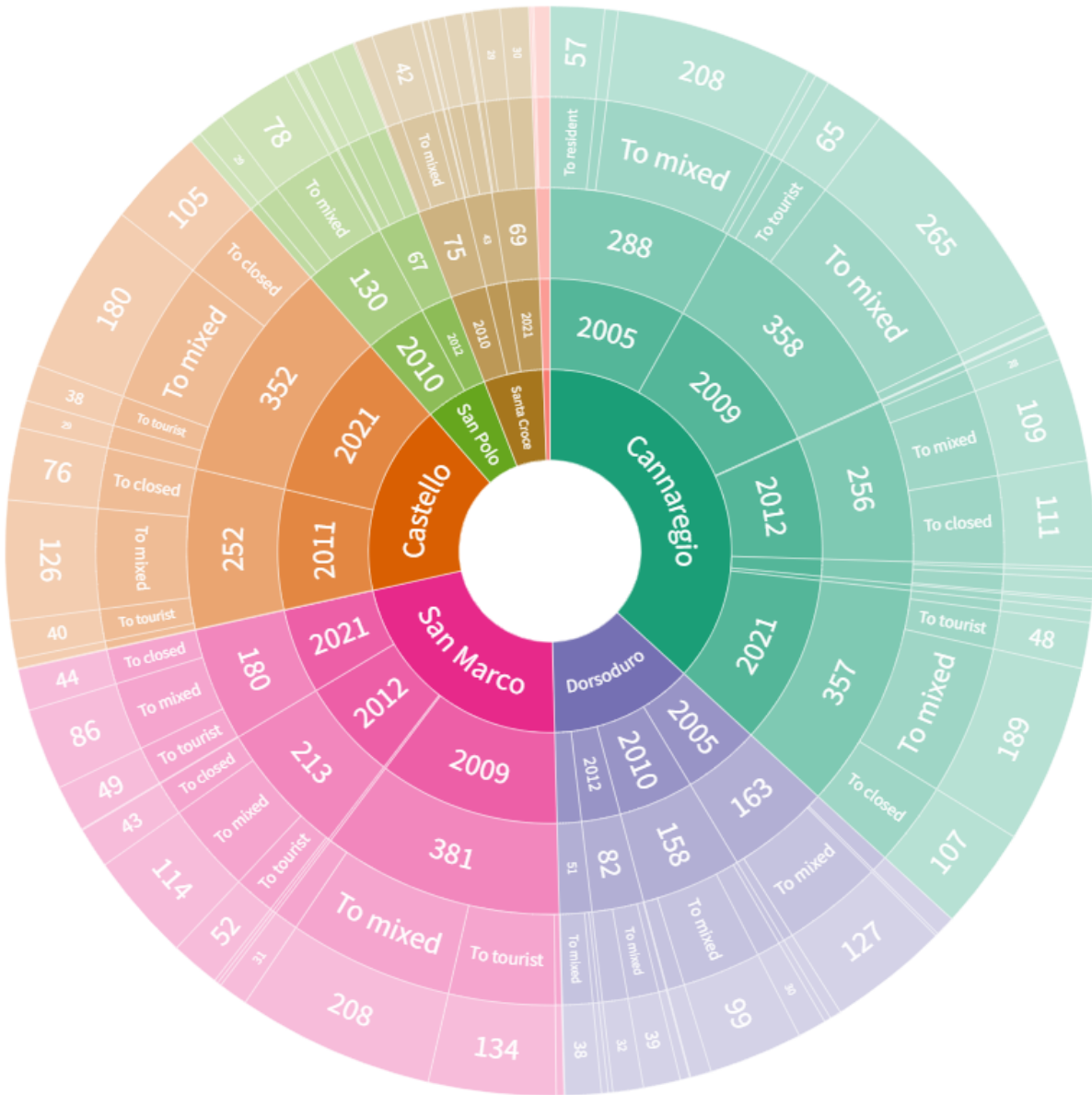
Figure 5.13: Stores changed from each year by sestiere

The graphic above shows the number of stores that changed from the previous entry. This then was broken down into whether the store changed into a store focused on residents, tourists, a mix of the two, or closed. It appears from the graphic that if a store were to change no matter where in Venice it is, it changes to a store that focuses on a mix of residents and tourists. This also makes the most logical sense for any business, especially when tourism is not year-round, but more time of year dependent than constant all year round and during the downtimes of tourism the residents can give enough business to allow the store to survive. The places in the historical city that seem to have the most closed stores are where it is mostly residential and not many tourists would be in the area. For example, high residential areas in Castello (left) and the northern half of Cannaregio that is away from the main street that runs the length of the sestiere (right).

Figure 5.14: Castello (left) closed areas and Cannaregio (right) closed areas

Chapter 6: Conclusion

It is no secret that economies worldwide were hit hard by the COVID pandemic. Venice relied heavily on tourism, which meant when travel bans were put in place and tourism halted, Venetian stores faced a shortage of customers, and by extension, a shortage of revenue. This project aims to quantify the extent to which Venetian stores were affected by COVID and to use the data collected to help Venetians and policy makers recognize the effect of an over reliance on tourism. We worked on this initiative with SerenDPT, a partner of the SmartDest project, while in Venice. To quantify the effect COVID had on the retail and hospitality sectors of Venice, we collected data from all shops in Venice, stored the data in a remote and easily accessible database, added the data collected in previous years to the database, and leveraged the data to create visualizations highlighting important trends.

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Appendix A: Glossary

English	Italian
Population	Popolazione
Shops/Stores	Negozi/Botteghe
Products	prodotti
Department Store	grande magazzino
Business	attività commerciale
Closed	chiuso
Open	Aperto
Goods	merce
the shopping center	il centro commerciale
the market	il mercato
the supermarket	il supermercato
the store	il negozio
I'm looking for...	Sto cercando...
Hello, I'm doing research on....	Ciao, sto farcendo ricerca su...
Is this data accurate?	è accurato questo dato?
economy	economia
retail market	mercato al dettaglio
the application	l'applicazione
Native/Local	Locale
Website	Sito web
Application	Applicazione
Exodus	Esodo
Opening	Inizio/Apertura
Closing	Chiusura
Inventory	Inventario
Tourist	Turista
Challenge	Sfida
Target	Obiettivo

Appendix B: Relevant Features of Shop Data

Attributes	Example Entry
Store Name	Trattoria Alla Palazzina
Address	Calle Michelangelo 1509
Sestiere	Giudecca
Address Number	1509
Latitude	45.1234
Longitude	12.1234
Shop Type	Trattoria
NACE Code	H.55.3.0.2
Group Type	Mixed
Year Open	-
Year Closed	-
Year Collected	2010
Image	2010_GD_1509

Appendix C: Technical Addendum

The Venice Shops application is built in Javascript and is currently being hosted at https://venice-shops.herokuapp.com. It uses the express framework and the dependencies are express, express-fileupload, fs, googleapis, mongodb, ol, select-pure, and serve-favicon.

USE: The process of using the application can be found in our Application Instruction Manual, which is linked on our website (https://sites.google.com/view/wpivenicestopsdata).

LOCATION: The code can be found at https://github.com/srdpt/VeniceShops

MAINTENANCE: The email for the Heroku account is venice.wpi@gmail.com and the password is xazNib-6jyfbe-sykxuc. The email for the MongoDB account containing the data is ve21.covid@gmail.com and the password is kacsyb-9bujkE-jebfuv. To make additions and modifications to the code, fork the VeniceShops repo and work from there. To publish the site, follow https://devcenter.heroku.com/articles/preparing-a-codebase-for-heroku-deployment, which will allow changes to be made and pushed while the app is live. Comments can be found in the code to explain the functionality and facilitate future additions and modifications. The features of the application and our suggestions for future improvements are as follows:

Features

1. Past Stores
   a. Imported all shops data into MongoDB
   b. Categorized the 100+ store types into 10 groupings (Clothing, …
2. Map Rendering
   a. Displays a map of Venice
   b. Can display collected stores (as map points/circles) from all 8 years (default)
   c. Can display the Airbnb locations (as map points) for any combination of years in the range 2009-2020
   d. Can geolocate the user on the map with the GPS button (assuming they are in Venice and using the app on a GPS enabled device)
   e. Can reset the map to the default view with the Home button

     f.   Hovering/mouse over a store point displays the store name (or sestiere and number, if no name is available)

     g.   Clicking on a store point opens the store details in a popup

     h.   Can resize the store points from small (default) to large (and vice versa) by toggling the resize button

     i.   Color coding

3. Map Navigation

     a.   Can zoom in/out on map using either pinch to zoom or the +/- buttons

     b.   Can pan the map by dragging it up/down/left/right

     c.   Can turn/re-orient the map by dragging rotationally

     d.   Can reset the map to the default orientation by clicking the Reset Orientation button

     e.   Can reset the map to the default size/orientation/location by clicking the Home button

4. Filter

     a.   Can filter by Stores

     b.   Can filter by Airbnb

     c.   Can filter by Year Collected

     d.   Can filter by Sestiere

     e.   Can filter by Shop Type

     f.   Can filter by Flagged stores

     g.   Can filter by Unflagged stores

     h.   Can filter by Open stores

     i.   Can filter by Tourist stores

     j.   Can filter by Resident stores

     k.   Can filter by Mixed stores

     l.   Displays the number of stores returned (for the current filter settings)

     m. Displays the number of Airbnbs returned

5. Timelapse

     a.   Can cycle through the years for the current filter settings, by clicking on the Cycle Years button

          i.   the cycle year will display under the button

          ii.   The store and/or Airbnb points will display for each cycle year

          iii.   The store and Airbnb counts will display for each cycle year

     b.   Can pause/resume the year cycling by clicking the Pause/Resume Cycling button

     c.   Can end the year cycling by clicking the End Cycling button

6. Data Collection

     a.   To edit a previously collected store, click on its map point to open the store detail

i. Can mark the store for deletion by clicking the Trash/Delete icon

ii. Can edit that year's store detail by clicking the Pencil/Edit icon
   1. Can select a photo to submit by clicking the Choose File button
   2. If the store entry has an associated image, the photo will display (can click on a store's associated image to open a larger version)
   3. Can edit the store's Name, Year, Store Type and Note
   4. Can clear the store's Name, Year, and Note by clicking the corresponding Clear buttons
   5. Can set the store's Type to Closed by clicking the corresponding Clear button
   6. Can mark the store as Flagged by checking the 'Flagged' checkbox
   7. Can cancel all edits by selecting the Cancel button
   8. Can cancel all edits and close the popup by clicking anywhere on the map
   9. Can save all edits by selecting the Submit button (user prevented from submitting a store that doesn't have a year, or a flagged store that doesn't have a Note)

iii. Can define a new store for that address by clicking the +/New button
   1. Can select an image to submit by clicking the Choose File button
   2. Can add the store's Name, Store Type and Note (the Store Year will default to the current year)
   3. Can clear the store's Name, Year, and Note by clicking the corresponding Clear buttons
   4. Can set the store's Type to Closed by clicking the corresponding Clear button
   5. Can mark the store as Flagged by checking the 'Flagged' checkbox
   6. Can cancel the addition of the store by selecting the Cancel button
   7. Can cancel addition of the store and close the popup by clicking anywhere on the map
   8. Can add the new store to the database by selecting the Submit button (user will be prevented from submitting a new store that doesn't have a year or a photo, or a flagged store that doesn't have a Note)

iv. Can navigate to previous year's entries (if collected) by clicking the Previous Entry button

v. Can navigate to next year's entries (if collected) by clicking the Next Entry button

      vi.   When there is no previous (or next) entry, the Previous (or Next) Entry button will be disabled

    b. To add a store at a new address, click the +/New button on the top right toolbar

        i.   Can select the store's sestiere with the Sestiere dropdown

        ii.   Can select an image to submit by clicking the Choose File button

        iii.   Can add the store's Street, Number, Latitude, Longitude, Name, Store Type and Note (the Store Year will default to the current year)

        iv.   Can clear the store's Street, Number, Latitude, Longitude, Name, Year, and Note by clicking the corresponding Clear buttons

        v.   Can automatically complete the Latitude and Longitude inputs by pressing the Find Coordinates button (user selects a location on the map and the corresponding coordinates are entered into the Latitude and Longitude inputs)

        vi.   Can set the store's Type to Closed by clicking the corresponding Clear button

        vii.   Can mark the store as Flagged by checking the 'Flagged' checkbox

        viii. Can cancel the addition of the store by selecting the Cancel button

        ix.   Can cancel addition of the store and close the popup by clicking anywhere on the map

        x.   Can add the new store to the database by selecting the Submit button (user will be prevented from submitting a new store that doesn't have number, a latitude, and longitude, year, or a photo, or a flagged store that doesn't have a Note)

7. Settings/Download

    a. Can manage the mapping of each store type to Tourist, Resident, or Mixed Use with the Settings button (changes made through the settings button are persistent and global)

    b. Can download the data for all stores returned in the filter set (i.e. all visible store points on the map)

    c. Download is a CSV file, with a row for each (instance of a) store and a series of calculated columns designed to facilitate analysis

Suggestions

1. Localization - add the ability to switch text labels from English to Italian (& back). E.g. https://lokalise.com/blog/json-l10n/

2. Map - replace the circle re-sizer with a range slider control (https://www.w3schools.com › howto_js_rangeslider)
3. Database - migrate the data in MongoDB to a more centralized account (download the data, create a new MongoDB account [maybe with venice.wpi@gmail.com], put the data into the new account, replace the references to the database in the code to reflect the change)
4. Data - find data from 2019 team and integrate into the database
5. Data - find pictures from data points from previous years and add them to their associated entries (many of the images can be found on our website)
6. Data - write script to run through the shops data and combine the 'info' arrays for all data points with the same address and very similar coordinates (there are many data points, specifically from 2015, that should be included in pre established locations but were instead included as separate locations with the same coordinates)
7. Data - standardize the structure of the Google Drive photo directory (move to a more secure location, divide images into separate folders for years and subfolders for sestiere)
8. Data - address all flagged entries
9. Login - Implement authentication/authorization
10. UI - modify the popups such that the cancel and submit buttons can only be seen when the popup is scrolled accordingly (take advantage of the min-height css property)
11. UI - add a key to explain the meaning of the colors of the dots (color mappings are determined by the 'colors' variable in public/js/scripts.js)
12. Store Detail - Add support for navigating to the store with the next/previous address number from the detail popup
13. Store Detail - Add support for multiple photos/gallery (having a photo of store interior thru window could be help verify store type)
14. Store Detail - Modify the detail display to show the entry that corresponds to the most recent applicable year in the filters rather than the most recent year in general (if a store has entries in 2004, 2015, and 2021 and the 2015 filter is applied, the popup will display the 2021 entry when the circle is clicked when it should instead show the 2015 entry)
15. Store Detail - Add support for editing the address and location of locations
16. Store Detail - Add ability to open detail popup of a specified store through a queries in a search bar
17. DC - Add support for a data collection (DC) mode (accessed through the login functionality);
    1. Add support to open the store detail window by specifying its District Number (assuming it was previously collected)
    2. Make app mobile device friendly, better touch support (for low resolution finger input)

3. Make map refreshes remember the current filter selections
4. Make the map geo-locate the user's position on the map and orients map in direction of travel

18. DC - Add support for off-line data collection (when signal drops/unavailable). Spool submissions to a file and upload when connection is restored.
19. DC - Capture the collector's name/id in the database
20. Timelapse - Option to step forward or backward a year in Timelapse mode (like in a debugger)
21. Filter - Add ability to search Notes (from the Filter pane)
22. Filter - Add ability to search by District Number
23. Filter - Add ability to filter by entries with images
24. Admin - Add an Administrator page (restricted access)
    1. Add support to CRUD (Create, Read, Update, Delete) User Accounts
    2. Add support for User Management: Roles (e.g. admin, data collector, end user) & user-role association
    3. Add support to manage stores marked as delete/archive (actual delete or remove marked as delete/archive flag)
    4. Add support to update store details in a list view
    5. Add support to execute predefined Reports, and display the results
    6. Add support to CRUD custom Reports
    7. Add support to CRUD group-category mappings
    8. Add support to CRUD text label localization
    9. Add support to "skin" the application (i.e. customize the look and feel)
    10. Add support for map association (map configuration)
    11. Add support for map boundaries (map configuration)
25. Misc - Recategorize the 'Radio and Television' type, recategorize or remove the 'Stall' type
26. Misc - Address data points with type 'Undefined'

Appendix D: Shop Type Super-Categories

Clothing Stores:
Clothing, Costumes, Children's Clothing, Gloves, Men's Clothing, Shoes, Undergarments, Women's Clothing

Drug Stores:
Cosmetics, Medical Goods, Pharmacy

Entertainment:
Casino, Entertainment, Movie Theater

Food and Beverage:
Bakery, Butcher, Candy, Coffee, Dairy, Gelateria, Liquor, Produce, Seafood, Wine

Grocery Stores & Supermarkets:
General Store, Grocery Store

Lodging:
Bed and Breakfast, Guest Houses, Hotel, Hotel with Restaurant, Hostel

Restaurants & Bars:
Bar, Cafe, Fast Food, Pizzeria, Restaurant

Services:
Apartment Rental, Bank, Barber, Car Rental, Computer Services, Delivery, Dry Cleaner, Electronics Repair, Film Studio, Fitness, Funeral Services, Graphic Design, Hair Salon, Hospital, Jewelry Repair, Laundromat, Leather Repair, Library, Masseuse, Money Transfer, Nail Salon, Perfume, Photo Store, Photocopy, Photographer, Post Office, Printing, Real Estate, Repair, Spa, Study Agency, Swim, Tailor, Tattoo and Piercing, Transportation, Travel Agency, Veterinarian, Warehouse, Wedding

Specialty Stores:
Accessories, Antiques, Art, Art Gallery, Boat Supplies, Books, Coins and Stamps, Computer, Electrical Appliances, Electronics, Exchange, Eyewear, Fishing, Florist, Furniture, Glass, Hardware, Household Goods, Jewelry, Knives, Leather Goods, Light Store, Luxury, Mask, Metal Work, Music, Musical Instruments, Newspaper, Office Supplies, Pawn Shop, Pet Store, Picture

Frames, Souvenirs, Sporting Goods, Stationery, Tobacco, Textiles, Toys, Woodwork, Other Retail

Other:
Closed, Undefined, Radio and Television, Stall