Sub-national Level Indices to Measure Sustainable Tourism in the United States

Ethan Chen, Jacob Cohen, Anna Hennessy, Jenna Tan, and Sharon Wu

August 28, 2023

Abstract

Past research has created a foundation for national-level sustainable indices in order to compare countries' commitments to sustainable tourism. However, these indices lose detail at the city level. In particular, we note that no sub-national sustainable tourism index exists. In this paper, we use indicators in the economic, social, and environmental and policy categories to measure sustainable tourism across 50 U.S. cities. We discuss the research process of selecting the categories and the indicators within them, and further explain the methodology for city selection, index weighing, and indicator calculations for each city. Our primary findings involve an overall weighted ranking of the 50 cities with a separate ranking for the cities with regards to each of the three categories. Lastly, we consider correlations with political and economic factors with respect to the indicators used. These observations have important implications for policymakers and responsible tourists, while also promoting sustainability in host communities.

Keywords: sustainable tourism; sustainable tourism index; ESG; sustainable tourism measurement

1 Introduction

A part of Cornell's Student Multidisciplinary Applied Research Teams (SMART) Program, the Sustainable Tourism Index (STI) team aims to create a sustainable tourism index for cities across the U.S. The goals are to allow for comparisons between cities' commitment to sustainable tourism, to inform policymakers and responsible tourists, as well as to promote sustainability in host communities.

In this paper, we will explore the relationship between tourism and sustainability. Our literature review considers the multi-disciplinary nature of sustainable tourism by researching its social, economic, environmental, technological, and cultural impacts. We then explain the methodology and construction of a sustainable tourism index, as well as the findings and implications we can draw from the results.

1.1 Background

1.1.1 Sustainability

According to the United Nations (1987), sustainability is meeting our own needs without compromising the ability of future generations. The most common way to operationalize this is through an Environmental, Social, and Governance (ESG) framework. Our index aims to include other factors of sustainability without primarily focusing on these three main categories.

The United Nations World Tourism Organization (UNWTO) advocates for the value of sustainable tourism, especially because of its alignment with its many sustainable development goals and the impact that it has on economic development. Beyond that, countries are slowly recognizing the need for sustainable tourism as cultural heritage sites are deteriorating and the pandemic has impacted many local economies. To compare these countries' commitments, national-level indices exist. However, these indices lose detail that sub-national indices capture, such as which cities are outperforming others and helping their countries'

overall sustainability goals. We recognize the absence of a sub-national level index for the U.S. in sustainable tourism. As such, we aim to create an index that considers environmental, policy, economic, and social factors in 50 popular tourist cities located within the United States in order to fill in this gap.

1.1.2 Environmental, Social, Governance (ESG) Framework

A common method used to operationalize the definition of sustainability is the Environmental, Social, and Governance (ESG) framework. This approach gives insight into the opportunities and risks associated with three important aspects of sustainability.

While ESG is a popular way to conceptualize and measure sustainability, it is not the only framework used. Several existing indexes, including the The Economist's Intelligence Unit (2018)'s Sustainable Tourism Index and the World Tourism Organization (2022)'s measurements of sustainable tourism consider factors outside of those included in a pure ESG approach. Our index takes inspiration from the ESG framework but aims to incorporate categories in addition to environmental, social, and governance.

1.2 Finding Summary

In our findings, we rank cities based on their present commitment to sustainability in addition to policies that outline future plans to increase sustainability. Through our ranking, we also analyze cities that perform well on different indicators ranging from how small their wage gaps are by social identity to the existence of a zero waste policy. From this, we recommend areas of improvement in sustainability for lower-ranking cities to focus on.

Our research finds that, out of the 50 cities in our index, the top 3 cities in terms of sustainable tourism are: Boston, MA; Minneapolis, MN; and Portland, WA. We found that the top 10 cities in our overall ranking tended to be ranked quite high in at least one subcategory, rather than simply being above average in all of them. For example, the top-ranked sustainable tourism city - Boston, MA - was also the top city for environmental

sustainability. On the other hand, the bottom three cities were: Houston, TX; New Orleans, LA; and Memphis, TN.

2 Literature Review

Before developing the index, we conducted a comprehensive literature review to identify commonalities and differences in perspectives in current research on sustainable tourism and to find potential indicators to include in our final index. Our key questions are: how does current literature define and regard sustainable tourism from a cross-disciplinary perspective? What indicators or variables that would be good measures to be included in our index?

2.1 Methodology

Using Scopus to source our research, we restrict our focus to US cities with five different disciplines: Social Science, Business and Economics, Environmental Studies, Engineering, and Arts and Humanities

Under each discipline, we search the keywords: "sustainable tourism", "sustainable; tourism", "tourism sustainability", "tourism index", "tourism measurement", and "sustainable tourism measurement". To ensure credibility, we sort the results by top citations and select articles from top-ranking journals.

The following table shows how many search results appeared for each term and category. A green-highlighted cell indicates an area where we pulled articles from the review.

	Social Sciences	**Business and Economics**	**Agriculture and Environment Sciences**	**Engineering**	**Arts and Humanities**
"sustainable tourism"	465 results	880 results	45,496 results	34 results	23 results
"sustainable" AND "tourism"	967 results	886 results	606 results	152 results	66 results
"tourism sustainability"	23 results	567 results	391 results	1 result	0 results
"tourism index"	7 results	198 results	386 results	0 results	0 results
"tourism measurement"	165 results	253 results	118 results	0 results	0 results
"sustainable tourism measurement"	14 results	18 results	14 results	0 results	0 results

2.2 Findings

2.2.1 Social Sciences

Sustainable tourism aims to address the negative impacts of conventional tourism by enhancing the quality of life for host communities, providing high-quality experiences for visitors, and maintaining the balance between economic trade-offs and resource conservation (Choi and Sirakaya-Turk, 2005). Sustainable tourism involves four distinct stakeholders: present tourists, present host regions, future tourists, and future host regions, based on Edward Freeman's Stakeholder theory (Byrd, 2007). A successful stakeholder approach unites stakeholder interests, fosters collaboration, understands host community attitudes and monitors visitor demographics to ethically and efficiently plan for future impacts.

2.2.2 Business and Economics

Resilience planning stresses tourism's ability to adapt to change and recover from detrimental change. This approach addresses the deterioration or loss of tourism facilities, infrastructure, environmental and cultural resources, and skilled employees (Lew, 2014). Additionally, as tourists increasingly seek niche destinations, sustainable tourism is becoming increasingly crucial for economic longevity. Sustainable positioning plays a role in managing deterioration and declines in tourism (Hassan, 2000). For a destination to be sustainably positioned, collaboration between private and public sectors as well as the community is essential. Choi and Sirakaya, (2006) suggests that as little as 10% of tourism revenue stays within the community, while the rest goes to multinational corporations.

2.2.3 Environmental Studies

Tourism contributes to economic growth but also has detrimental environmental impacts. Specifically, it generates significant greenhouse gas emissions through transportation, accommodation, and tourist activities and produces a large amount of waste through human

activities such as construction and infrastructure development (Farrell and Marion, 2001). Environmentally sustainable tourism emphasizes the protection of the environment to benefit wildlife, biodiversity, landscapes, and local communities (Stronza et al., 2019). For example, ecotourism mitigates those negative effects while promoting the environmental conservation and diversification of local livelihoods (Stronza et al., 2019). However, to achieve environmental sustainability, the industry must effectively assess and monitor its environmental impacts.

2.2.4 Engineering

Smart tourism leverages data and Internet of Things (IoT) technologies to enhance sustainability, community well-being, and tourist experiences (Choi and Sirakaya-Turk, 2005). Initiatives like Smart and Connected Communities and Smart Cities aim to improve livability and address regional inequalities (Sun et al., 2016). These technologies improve vacation planning and create engaging tourist experiences, while also addressing inequalities between regions (Loureiro and Nascimento, 2021). Estêvão et al. (2019) found the link between renewable energy and sustainable tourism development in which cleaner technologies and continuous recycling of materials contribute to environmental conservation.

2.2.5 Arts and Humanities

"Peace tourism" in the arts and humanities field considers tourism a framework for promoting peace on local, regional, and global levels by fostering goodwill, harmony, respect, and economic growth. D'Amore (2009) argues that peace tourism aligns with concepts including environmental preservation, sustainable development, poverty reduction, and cultural heritage enhancement. However, Lansing and Vries (2007) questioned that sustainable tourism might be a marketing ploy without substantial effectiveness or real change due to the lack of a strict definition and limited enforcement.

3 Data and Methodology

3.1 Data

Before we began researching possible indicators, we first needed to define our time scale. We understood the impact that the pandemic had on the tourism industry, so we wanted to make sure that our data and index captured the tourism industry at its most recent state without lingering exogenous factors. As such, we decided to use data primarily for 2019. If we were unable to retrieve such data, we found the closest data source before or after 2019 and inflated or deflated it to 2019 to ensure consistency.

Once we defined our time scale, we selected our cities. To do so, we multiplied two factors: the population of the city and the location quotient (Appendix **??**). This score encompasses both the relevance of the city as well as the relevance of the tourism industry. We then chose the top 50 cities with the highest score and began collecting data on them.

After searching through publicly available and reputable sources, we narrowed our potential list of indicators down to three main categories with seven variables:

- Economic
  - Wages
  - Small Medium Enterprises
- Environmental
  - Renewable Energy
  - Greenhouse Gas Emissions
  - Zero Waste Policy
- Social
  - Wage Gap by Sex
  - Wage Gap by Minority Status

3.2 City Selection

To determine the cities, we want an index that captures cities that are both relevant and have prominent tourism industries. To capture the relevance of a city by scale, we use United States Census Bureau (2019c) data to find the population of each city by Metropolitan Statistic Area (MSA) in 2019. Then, to measure the impact of tourism on the local economy, we measure the location quotient, an idea that was first introduced to us through Habans and Plyer (2018). The formula for the location quotient is as follows:

$$LQ_{city} = \frac{\frac{e_t}{e}}{\frac{E_t}{E}}$$

where e_t represents the local employment in the tourism industry of that city, e represents the total local employment, E_t represents the U.S. employment in the tourism industry, and E represents the total U.S. employment. With this formula, we see that the location quotient is a ratio indicating how many tourism jobs are in the city compared to the national average. In order to calculate the location quotient, we found local and total employment data at a sub-national and national level in 2019 through the U.S. Bureau of Labor Statistics (2019). The jobs that we looked at are listed as follows: Hotel, Motel, and Resort Desk Clerks; Maids and Housekeeping Cleaners; Waiters and Waitresses; Maintenance and Repair Workers, General; Gambling Dealers; Cooks, Restaurant; Dining Room and Cafeteria Attendants and Bartender Helpers; Bartenders; Janitors and Cleaners, Except Maids and Housekeeping Cleaners; First-Line Supervisors of Housekeeping and Janitorial Workers; Food Preparation Workers; Hosts and Hostesses, Restaurant, Lounge, and Coffee Shop; Dishwashers; Cooks, Short Order; Cashiers.

Finally, with these two factors, we gave them a score in order to rank the cities in descending order. The top 50 with the highest score was chosen for our final index.

3.3 Data Documentation

3.3.1 SME as Percentage of Tourism Business

For residents of a city to feel the economic impacts of tourism, the money tourists spend needs to stay within the community, but most of the time, the majority of tourist dollars leave via money spent at multinationals in a phenomenon known as tourism leakage Choi and Sirakaya, (2006). We argue that small and medium enterprises (SMEs) are more likely to direct capital into the host community than larger businesses. Therefore, to measure tourism leakage, we used SMEs as a proxy.

Habans and Plyer (2018) find that data from two NAICS categories—71 (Arts, Entertainment, and Recreation) and 72 (accommodation and food services)—are representative of the businesses in the tourism industry. We use these two categories in our SME indicator.

We define SMEs to be firms that have less than 500 employees, and large firms to be ones that have 500+ employees. Our data comes from the United States Census Bureau's Data Tables using Establishment Industry (United States Census Bureau, 2019a).

For each city, we find the percentage of employees in SME firms by using the following formula:

$$psme_{city} = \frac{(t_{71} - l_{71}) + (t_{72} - l_{72})}{t_{71} + t_{72}},$$

where $psme_{city}$ is the percentage of employees in SMEs in the city, t_{71} is the total number of firms in category 71 in the city, t_{72} is the total number of firms in category 72 in the city, l_{71} is the number of large firms in category 71 in the city, and l_{72} is the number of large firms in category 72 in the city.

In the numerator, we subtract the number of large firms from the total number of firms in each category to find the number of small firms.

The computed value for each city is the percentage of employees in the tourism industry that work at SMEs.

3.3.2 Renewable Energy Rating

Tourists and the tourism industry need to utilize city services like public transportation, water and energy, and more. Therefore, for environmentally responsible tourism, tourists must rely on the environmental friendliness of the host communities' services, which is why we include a renewable energy indicator and greenhouse gas emissions.

The American Council for an Energy-Efficient Economy (ACEEE) ranks 75 cities on a clean energy scorecard. The results are updated annually (Ribeiro et al., 2019).

The rankings are expressed as a numerical value out of 100. The factors considered in the ranking are:

1. local government operations (9 points total)
2. community-wide initiatives (16 points total)
3. buildings policies (30 points total)
4. energy and water utilities (15 points total)
5. transportation policies (30 points total)

In the 2019 scorecard, 48 of the 50 cities in our index are included. For the two remaining cities, we calculate a rating using the following methodology:

1. Cape Coral: There is data for Cape Coral in the 2020 scorecard. We scale it by multiplying the 2020 rating by $\frac{\text{median rating in 2019}}{\text{median rating in 2020}}$.
2. North Port: There is no data for North Port in either the 2019 or 2020 scorecard. We use the state average for Florida from 2019 and multiplied it by a factor of 2 (since the state average is scored out of 50 and cities are scored out of 100) to get the rating for North Port.

3.3.3 Greenhouse Gas Emission

Measuring greenhouse gas (GHG) emissions associated with tourism enables us to better assess the carbon footprint of the tourism industry and understand the effectiveness of cities' policy implementation. However, it is challenging to accurately reflect the GHG emissions

level specifically attributed to the tourism industry.

The first challenge in collecting data for this section involves addressing the lag time associated with data releases. We initially source data from The Global Covenant of Mayors' Data Portal for Cities, which systematically collected compatible GHG emissions data across 21,389 U.S. cities. However, this dataset is from 2015, which limits our ability to measure the current carbon footprint of tourism. To mitigate the drawbacks of outdated data, we turned to source more recent data from individual municipal governments publications, such as cities' Climate Action Plans, GHG Emissions Inventories, GHG Emissions Reports, and a City GHG Inventory compiled by The Brookings Institution (2020). Finally, among the 50 cities we selected, about half of them have data from 2019, while the remaining data spans from 2015 to 2018.

Another challenge in creating a GHG emissions indicator involves determining the share of each city's tourism industry responsible for overall urban emissions. We approximate the percentage using the average length of stay for both international and domestic travelers in 2019. According to the National Travel and Tourism Office (2022), approximately 79.3 million international visitors travelled to U.S. cities in 2019, with an average length of stay of 18 nights (U.S. Travel Association, 2020b). For domestic travelers, there are around 2.3 billion person-trips (one person on a trip away from home overnight in paid accommodations or a day or overnight trip to places 50 miles or more away from home) (U.S. Travel Association, 2020a) with an average length of stay of approximately 3.5 nights (Poster, 2022). To achieve the overall average length of stay, which represents the length of stay for both international and domestic tourists to a city, we use a weighted average formula:

$$\begin{aligned} Weighted\ Avg.\ Stay &= \frac{Int.Visitors \times Int.\ Stay + Domestic\ Visitors \times Domestic\ Stay}{Int.\ Visitors + Domestic\ Visitors} \\ &= \frac{79.3\ million \times 18.3\ nights + 2.3\ billion \times 3.5\ nights}{79.3\ million + 2.3\ billion} = 3.99\ nights \end{aligned}$$

Using the weighted average stay for tourists and an average length of stay for residents

in their own cities (310 days), which is estimated based on legal holidays and annual leaves, we obtain a proxy for the percentage of emissions contributed by the tourism sector relative to all sectors in a city. The overall GHG score is then derived by:

$$ghg_i = GHG_i \times \frac{Tourists_i \times 3.99}{Tourists_i \times 3.99 + Population_i \times 310}$$

where ghg_i and GHG_i denote the GHG emission score and total GHG emissions for a city respectively while $tourists_i$ and $population_i$ stand for the number of visitors and the populations for a city. It is important to note that the total GHG emissions data is provided at a city level rather than a Metropolitan Statistical Area (MSA) level, and we employ the primary city as a representative of its MSA. Moreover, the number of visitors in 2019 for each city is obtained from various data sources, such as news reports, articles, and other forms of publication, similar to how we collected data on the actual GHG emissions. This diversity in data sources results in variations in accuracy, reliability, and compatibility across data for different cities.

3.3.4 Wage Gap by Sex

For sustainable tourism, it is important for the workers in the industry to be fairly compensated, and fair compensation can be looked at from multiple but equally important angles. One approach is whether workers in this industry make enough money to meet their basic needs. This is captured by our indicator Hospitality Wages as a percentage of living wages.

The wage gap by sex is expressed as the percentage of male earnings earned by female employees as found in the US Census Bureau (United States Census Bureau, 2019b).

Following The Data Center, we select "Food Preparation and Serving Related Occupations" and "Arts, Design, Entertainment, Sports, and Media Occupations" to be the two categories representative of the tourism industry (Habans and Plyer, 2018). The wage gap percentage for each city is calculated using the following formula:

$$pwg_{city} = \frac{wg_f + wg_a}{2},$$

where pwg_{city} is the wage gap percentage in the city, wg_f is the wage gap percentage in food preparation and serving related occupations, and wg_a is the wage gap percentage in arts, design, entertainment, sports, and media occupations.

3.3.5 Wage Gap by Minority/Non-Minority

As stated in the previous section, fair compensation for workers in the tourism industry is an important part of being economically sustainable. The second indicator we choose to measure this is whether women and minorities are being fairly compensated relative to men and the majority.

We define non-minorities as individuals who are Caucasian and non-Hispanic.

The wage gap by minority status is expressed as the percentage of non-minority median annual earnings earned by all ethnicity. The data on wages for both non-minorities (Bureau, 2019) and all ethnicity (United States Census Bureau, 2019b) is from the US Census Bureau.

We calculate the wage gap percentage for each city using the following formula:

$$pwg_{city} = \frac{w_{all}}{w_{non-minority}},$$

where pwg_{city} is the wage gap percentage for the city, w_{all} is the median annual earnings for all employees in the tourism industry, and $w_{non-minority}$ is the median monthly earning for non-minority employees.

3.3.6 Zero Waste Policy

It is difficult for individuals and businesses to operate in a sustainable manner without the help of city policies. For example, an individual or business cannot properly recycle if the city's waste management policy has everything ending up in the landfill regardless of how

trash is recycled. The Zero Waste Policy indicator captures whether or not a city is targeting a high percentage of waste diversion in the coming decades, which would allow individuals and businesses to dispose of their waste in a more sustainable manner.

We utilized (Wastedive, 2022) mapping of zero-waste cities as a database for which cities had a zero-waste policy implemented in 2019 or prior. For any cities not included in Wastedive's database, we searched for zero-waste policies on the city website and in the news. If either Wastedive's database or our search resulted in finding a zero waste policy implemented in 2019 or prior, that city was coded 1; else, that city was coded 0.

3.3.7 Hospitality Wages as a Percentage of Living Wage

Using the database provided by the U.S. Bureau of Labor Statistics (2019) for wages by metropolitan statistical area (MSA) and occupation, we first subset our data on the occupations of interest. Again, taking precedence from The Data Center (Habans and Plyer, 2018), the occupations of interest that encompass the hospitality and tourism industry are listed: Hotel, Motel, and Resort Desk Clerks; Maids and Housekeeping Cleaners; Waiters and Waitresses; Maintenance and Repair Workers, General; Gambling Dealers; Cooks, Restaurant; Dining Room and Cafeteria Attendants and Bartender Helpers; Bartenders; Janitors and Cleaners, Except Maids and Housekeeping Cleaners; First-Line Supervisors of Housekeeping and Janitorial Workers; Food Preparation Workers; Hosts and Hostesses, Restaurant, Lounge, and Coffee Shop; Dishwashers; Cooks, Short Order; Cashiers.

The database provides data for each MSA on the number of jobs and the average wage for each occupation. With these occupations, we then calculate the weighted tourism average of these wages by the number of jobs.

As for living wages, we source data from the Living Wage Calculator created by Dr. Amy K. Glasmeier and published by the Massachusetts Institute of Technology (MIT). The living wage calculator estimates the living wage of households depending on the number of adults and children. For the sake of our research, we observed one adult family with no

dependent children. The living wage is also collected for 2019, where we used an internet archive website, Wayback Machine, to get the data for that year. In the event, a city does not have data for 2019, we found the closest archive after 2019 and discounted it back using the GDP. Finally, the calculations are done by taking the weighted average of tourism wages (Tourism Wages) and dividing it by the living wage (Living Wages) as calculated by MIT:

$$\text{Ratio}_{city} = \frac{\text{Tourism Wages}}{\text{Living Wages}},$$

3.4 Methodology

3.4.1 Weighting

The next step is to weigh each sub-indicator within each category. For our final weightings, we decide to have everything be equal in weight. In short, the breakdown is as follows:

- Economic (33.33%)
  - Wages (50%)
  - Small Medium Enterprises (50%)
- Environmental (33.33%)
  - Renewable Energy (33.33%)
  - Greenhouse Gas Emissions (33.33%)
  - Zero Waste Policy (33.33%)
- Social
  - Wage Gap by Sex (50%)
  - Wage Gap by Minority Status (50%)

For the Social category, both the wage gap by sex and the wage gap by minority status observe the income inequality by their respective social identity. As such, it is intuitive to weigh them both equally. These two social identities do not seem to outweigh the other in terms of how they manifest themselves in the lives of others. For that reason, it is appropriate

to weigh them equally.

The Economic category encompasses both wages and small-medium enterprises (SMEs) with equal weight. The former measures the attractiveness of tourism jobs in comparison to the living wages. This means that for a single adult to live comfortably in the city they live in, then a tourism occupation should be at or above the living wage. Meanwhile, the latter tries to measure the amount of money that goes into the tourism industry that stays in the city. It does this by using the percentage of employees in SMEs as a proxy, where this proportion serves to capture how business may direct their revenues and profits. More employees in SMEs indicates that a city keeps its tourism dollars locally as these businesses are more likely to reinvest in the city.

As for the Environmental & Policy category, we also decide to keep equal weights. Although we do understand the importance of policy implementation, the binary nature of our zero waste policy can polarize the data more; if more weight is given to policy, then it tends to be that those that actually have a zero waste policy will stay at the top for the environmental & policy category. To account for this, we leave all weights equal. Meanwhile, all sub-indicators monitor the industry's usage and byproducts and so can be considered equal.

Finally, for the categories, we decide to treat these all equally as well. Each category plays an important role in the overall index in what they measure, and this is reflected in the fact that no one category outweighs another. In addition, due to the limited number of indicators, the data may be biased in how it favors one category over another, as one sub-indicator within that category can drive the data in one direction. To account for this, the categories are of equal weight. However, we experimented with different weights through the use of a dashboard built in Tableau, which we hyperlink in our Findings section.

3.4.2 Index Computation

After data collection and cleaning, almost all indicators are quantified in a way such that the higher the data value, the better or more sustainable the city's tourism industry is. As

a result, we decide that the higher the overall index score, the more sustainable a city's tourism industry is. To compute the index score, we first needed to normalize all our data and then add them together with the weighting mentioned earlier.

As such, all indicators except for Greenhouse Gas Emissions are normalized in the same way:

$$\text{Normalized Data Value}_i = \frac{X_i - X_{min}}{X_{max} - X_{min}}$$

for all i in X, where X represents the sub-indicator of interest. In order to normalize the Greenhouse Gas Emissions, we did the same normalization method but subtracted each normalized data value from 1. In this way, the smallest normalized data value is now the largest and vice versa.

The category scores are then taken for each city, where each category has its own respective weighting. Finally, the overall index score for each city is combined following the weighting as above:

$$\text{Score} = \frac{1}{3}\text{Economic} + \frac{1}{3}\text{Environmental} + \frac{1}{3}\text{Social}$$

4 Findings

4.1 Results

Figure 1 and figure 2 show the top and bottom 10 cities respectively, using the index where both categories and sub-indicators were of equal weight. Our top-ranked city, Boston, scores fifth in the economic category and first in the environmental and policy category (Figure 3 and Figure 4) while the bottom-ranked city, Memphis, ranks 45th in environmental and policy and 50th in the social category.

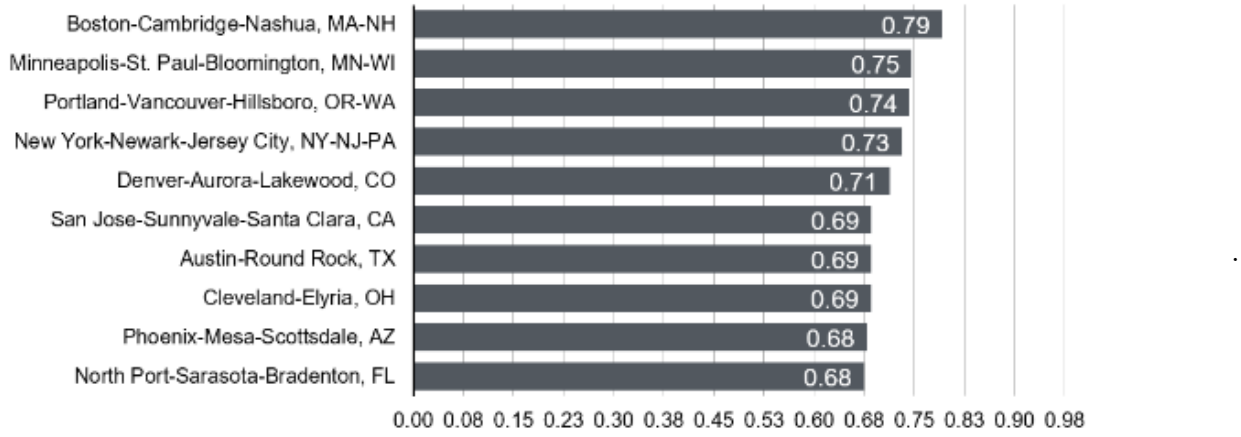

Figure 1: Top 10 cities

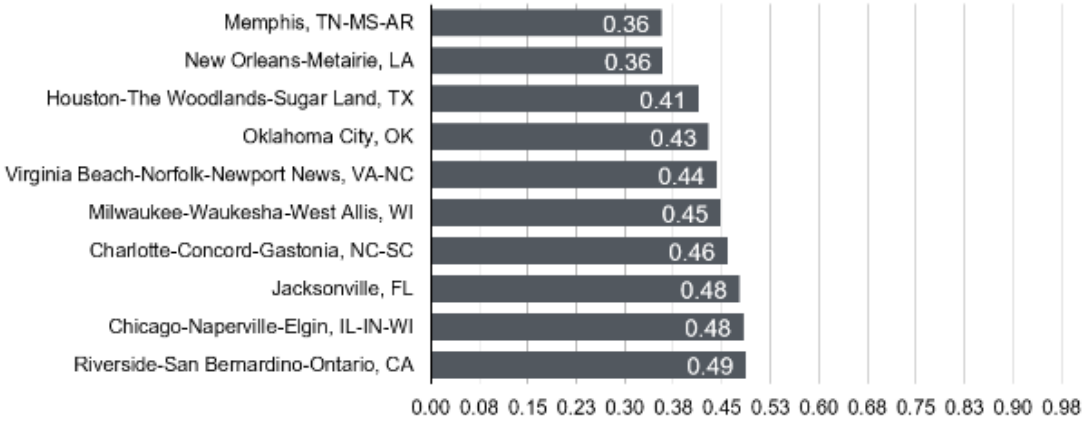

Figure 2: Bottom 10 Cities

The following figures show ranks by category:

The top-ranked 10 cities under the economic category are shown in figure 3 below:

Figure 3: Top Economically Sustainable Cities

The top-ranked 10 cities under the environmental category are shown in figure 4 below:

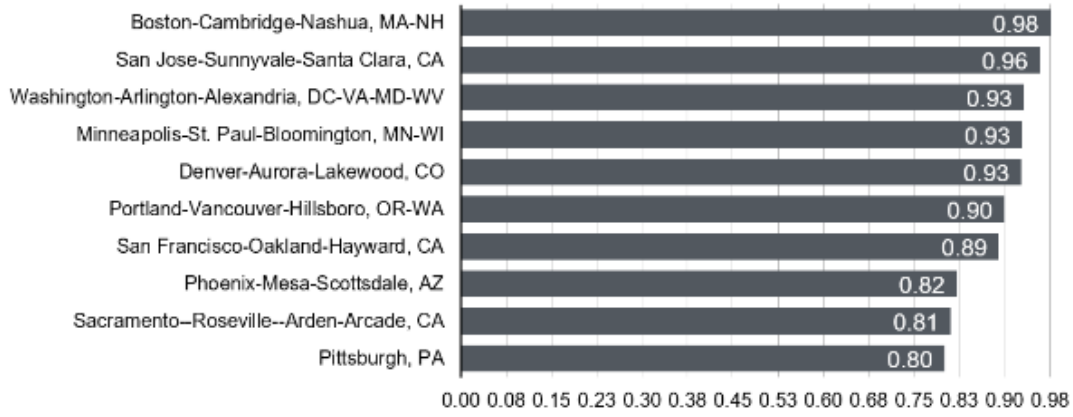

Figure 4: Top Environmentally Sustainable Cities

The top-ranked 10 cities under the social category are shown in figure 5 below:

Furthermore, we created a dashboard (Figure 6) to visualize our findings, including the overall index, top scorers in each category, a map including each city and their score, and sliders to adjust the weights of each category. This allows the end user to weigh the index at the category level based on what is most (or least) important to them.

The link to the dashboard is here.

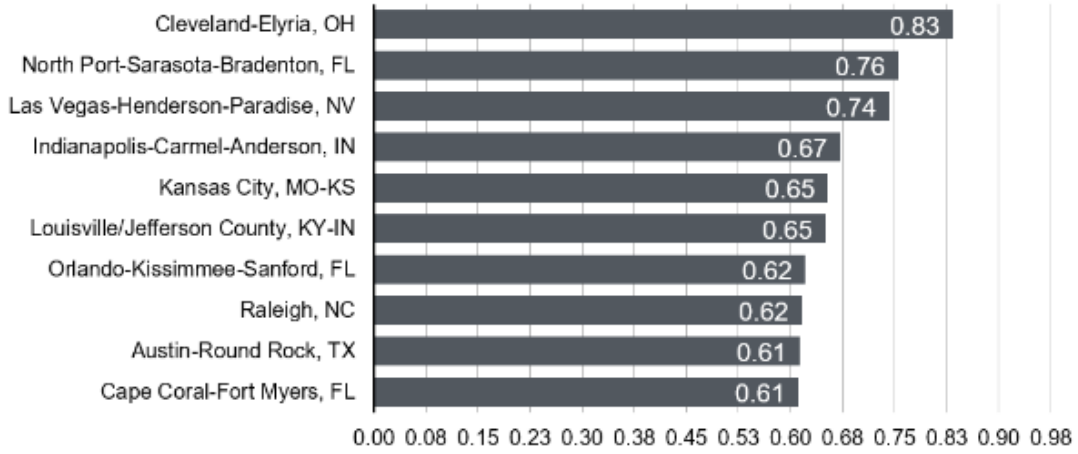

Figure 5: Top Socially Sustainable Cities

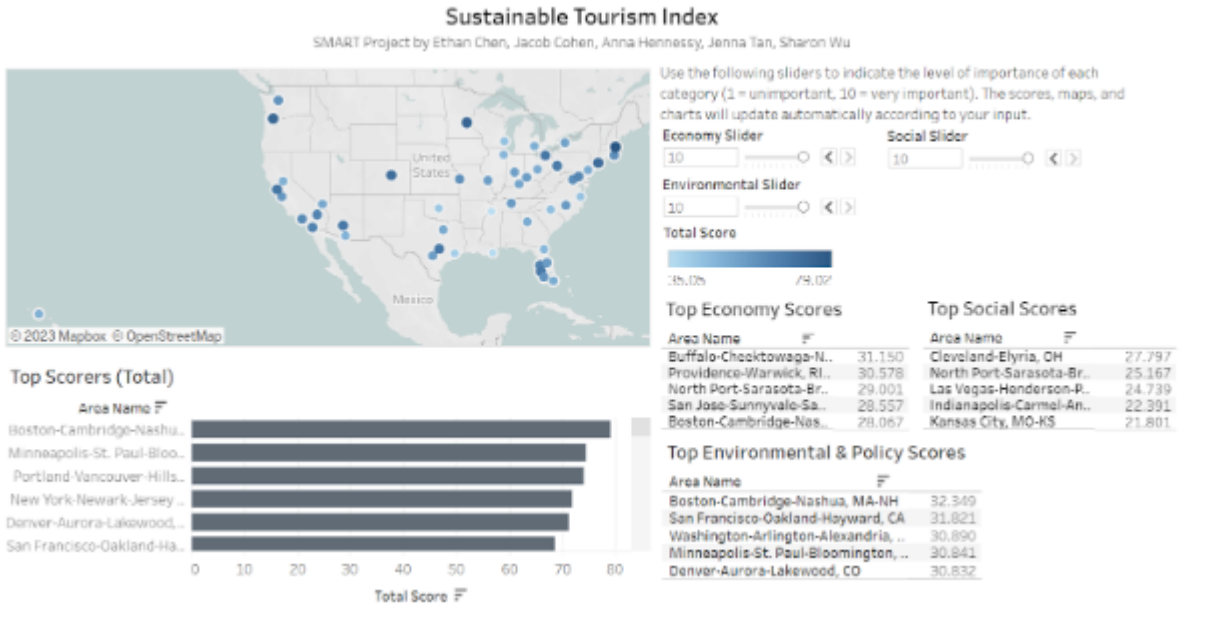

Figure 6: Dashboard

4.2 Correlation with Political and Economic Factors

We tested if there are significant differences between the mean index scores by how states vote politically (Republican vs Democrat). Political data is based off of the 2016 election results, as 2019 conditions are influenced by the preceding election. Taking a two-sample

t-test ($p = 0.01183$), we observe a significant difference between the mean scores by how a state votes, with states that lean Democrat ranking higher than states that lean Republican.

As for economic factors, we tested if income (using 2019 average wages in USD), population, and number of tourists have a significant correlation with the city's rankings. All of our metrics are based on 2019 data from the United States Census Bureau (2019c) and the U.S. Bureau of Labor Statistics (2019). We conclude that income and our index have a significant positive correlation, with higher-income cities ranking higher than lower-income cities (Table 1). Meanwhile, the population and number of visitors are not significantly correlated with our index. The correlations for all these tests can be found in Table 1.

Table 1: Correlation of social variables with Sustainable Tourism Index

	Sustainable Tourism Index
Income level (in USD)	0.5037***
Population	0.1859
Nr. of visitors	-0.0208

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

4.3 Limitations

For this research, we face data availability and time limitations. As we are limited to free, publicly available data sources, we are unable to address all of the indicators we want to include in the index. For example, AirBnB data looks at how short-term rentals affect the cost of living for residents. These observe the displacement of the city's residents for tourism, which is not sustainable. For others, we can not find data as we do not have the means to collect them or the data has not been collected. For example, residents' attitudes towards tourism in their city can be collected through a survey. This has neither been done on the sub-national level nor do we have the funding to survey residents of all 50 cities. In addition, researchers have collected that data in single-city studies but not on a wide enough scale to include in our index. A proxy that we did find was U.S. Census Data on attitudes toward

the neighborhood, but that does not directly translate to attitudes toward tourism. Finally, we also face time limitations. Policy indicators require extensive knowledge of each city's policies, which takes time and expertise to collect. To simplify policy indicators, we use a binary scale: 0 if the city does not have such a policy and 1 if the city does. But, this requires us to go through each city's government database and research their policy for sustainable tourism. This could lead to errors and is still time-consuming. As such, we decide to only keep one.

However, these limitations are where future researchers can expand upon our work. Future researchers should explore private and pay-walled data sources, and work to incorporate city policies to capture more elements of sustainable tourism. In addition, they can update the indicators with more recent data or expand the index to include more cities. Finally, our index scores further analyze how sustainable tourism relates to different economic and political factors of a city. With the foundation of sustainable tourism from different disciplines and inspiration from existing national indices, our index can be built upon.

References

Brookings Institution (2020, Oct). City ghg inventory.

Bureau, U. S. C. (2019). Median earnings in the past 12 months (in 2019 inflation-adjusted dollars) by sex by work experience in the past 12 months.

Byrd, E. (2007, 05). Stakeholders in sustainable tourism development and their roles: Applying stakeholder theory to sustainable tourism development. *Tourism Review 62*, 6–13.

Choi, H. C. and E. Sirakaya (2006). Sustainability indicators for managing community tourism. *Tourism Management 27*, 1274–1289.

Choi, H.-S. and E. Sirakaya-Turk (2005, 05). Measuring residentsâĂŹ attitude toward sustainable tourism: Development of sustainable tourism attitude scale. *Journal of Travel Research 43*, 380–394.

D'Amore, L. (2009). Peace through tourism: The birthing of a new socio-economic order. *Journal of Business Ethics 89*(Suppl 4), 559–568.

Estêvão, R., F. Ferreira, Ã. Rosa, K. Govindan, and I. Meidute-Kavaliauskiene (2019, 07). A socio-technical approach to the assessment of sustainable tourism: Adding value with a comprehensive process-oriented framework. *Journal of Cleaner Production 236*.

Farrell, T. and J. Marion (2001, 09). Identifying and assessing ecotourism visitor impacts at eight protected areas in costa rica and belize. *Environmental Conservation 28*, 215–225.

Habans, R. and A. Plyer (2018). Benchmarking new orleansâĂŹ tourism economy: Hotel and full-service restaurant jobs.

Hassan, S. S. (2000). Determinants of market competitiveness in an environmentally sustainable tourism industry. *Journal of Travel Research 38*(3), 239–245.

Lansing, P. and P. D. Vries (2007). Sustainable tourism: ethical alternative or marketing ploy? *Journal of Business Ethics 72*, 77–85.

Lew, A. (2014, 01). Scale, change and resilience in community tourism planning. *Tourism Geographies 16*.

Loureiro, S. and J. Nascimento (2021, 11). Shaping a view on the influence of technologies on sustainable tourism. *Sustainability 13*, 12691.

National Travel and Tourism Office (2022). Fact sheet: 2022 national travel and tourism strategy.

Poster, G. (2022, Mar). Travel in the us: Cool domestic travel statistics for 2022!

Ribeiro, D., S. Samarripas, K. Tanabe, H. Bastian, E. Cooper, A. Drehobl, S. Vaidyanathan, A. Jarrah, and M. Shoemaker (2019). The 2019 city clean energy scorecard.

Stronza, A. L., C. A. Hunt, and L. A. Fitzgerald (2019). Ecotourism for conservation? *Annual Review of Environment and Resources 44*(1), 229–253.

Sun, Y., H. Song, A. J. Jara, and R. Bie (2016). Internet of things and big data analytics for smart and connected communities. *IEEE Access 4*, 766–773.

United Nations (1987). Sustainability.

United States Census Bureau (2019a). 2019 susb annual data tables by establishment industry.

United States Census Bureau (2019b). Earnings in the past 12 months (in 2019 inflation-adjusted dollars).

United States Census Bureau (2019c). Metropolitan and micropolitan statistical areas population totals and components of change: 2010 - 2019.

U.S. Bureau of Labor Statistics (2019). Occupational employment and wage statistics.

Wastedive (2022). Mapping zero waste cities: Where local governments are pursuing waste prevention and diversion.

The Economist's Intelligence Unit (2018, Jan). The sustainable tourism index by the economist intelligence unit.

U.S. Travel Association (2020a, Mar). U.s. travel and tourism overview (2019).

U.S. Travel Association (2020b, Mar). U.s. travel answer sheet.

World Tourism Organization (2022). On measuring the sustainability of tourism: Mst.