FINAL REPORT

BUAN 6390: ANALYTICS PRACTICUM

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Contents

- Alignment with Problem Statement

c. Challenges and Limitations

- Data Gaps and Constraints
- Issues Faced During Analysis
- Lessons Learned

7. References

- Data Sources

1.Initiation Phase

a. Executive Summary

Overview of the Problem

Hawaii's tourism sector is a critical driver of the state's economy, generating significant revenue and supporting thousands of jobs. However, it is highly vulnerable to natural disasters and global crises, such as hurricanes and pandemics, which disrupt key metrics like occupancy rates, air travel, and employment. This project analyzed historical disaster impacts, employment trends, and predictive models to propose actionable strategies for enhancing disaster recovery and long-term resilience.

By leveraging data analytics, the project provides a framework for stakeholders to better understand and address the vulnerabilities of Hawaii's tourism sector, ensuring sustainable growth and improved economic stability in the face of future disruptions.

Key Objectives

- To quantify the effects of disasters on tourism metrics (occupancy rates, air travel, RevPAR) and employment trends.
- To assess regional variations in recovery timelines for key metrics and propose strategies for rapid disaster recovery.
- To build forecasting models to guide decision-making in aligning resources and strategies with projected trends.
- To propose data-driven strategies to mitigate economic losses during crises and foster resilience in Hawaii’s tourism industry.

Summary of Key Findings

- **Disaster Impacts:** Natural disasters significantly disrupt tourism metrics, causing sharp declines in occupancy rates and employment, particularly in accommodations and food services. Government jobs remain stable during crises, providing economic resilience
- **Seasonal Trends**: Peaks in tourism activity occur in December and March, highlighting reliance on holiday demand. Occupancy rates are the strongest positive driver of accommodation jobs, while high ADR negatively impacts employment.
- **Recovery Patterns:** Recovery times vary, and occupancy rates stabilize within 12–18 months, while financial metrics such as ADR and RevPAR take up to 24 months. Regional disparities exist, with Oahu recovering faster than other counties due to stronger infrastructure and diversified tourism.

b. Introduction

Problem Statement

Hawaii's tourism sector, a critical component of the state's economy, is exceptionally vulnerable to external shocks, including natural disasters such as hurricanes and volcanic eruptions, as well as global health crises like pandemics. These disruptions lead to significant declines in key tourism metrics such as occupancy rates, air travel, and visitor expenditures, which in turn impact thousands of jobs in the accommodation and food service industries. Despite the existence of broader recovery frameworks, a dedicated, data-driven strategy for the tourism sector's rapid recovery and long-term resilience remains absent.

The project aimed to analyze the following questions:

- How do disasters affect key tourism metrics, such as occupancy rates, air travel, and visitor expenditures?
- How are employment trends, particularly in accommodation and food services, impacted during and after disasters?
- What are the recovery patterns across regions, and what strategies can be developed for rapid disaster recovery and long-term resilience?

We identified that existing recovery frameworks for Hawaii's tourism sector are often generalized, lacking the specificity and actionable insights necessary to minimize economic losses and expedite recovery.

Project Justification

The tourism industry contributes significantly to Hawaii's GDP and supports the livelihood of a large portion of its population. Its stability is essential for economic health and societal well-being. However:

- Frequent disasters have shown the sector's vulnerability, underscoring the need for proactive recovery strategies.
- A lack of tailored, actionable insights delays recovery efforts and leaves the sector ill-prepared for future crises. This project addresses these gaps by leveraging data analytics to provide predictive insights and develop a comprehensive recovery framework for Hawaii's tourism and employment sectors.

Scope and Objectives

Scope

- Analyze historical disaster data, tourism metrics, and employment trends to understand past impacts.
- Develop and validate forecasting models to predict trends in tourism and jobs.
- Propose actionable recommendations for stakeholders to strengthen the tourism sector's resilience.

Objectives

- Quantify the impacts of disasters on key metrics such as occupancy rates, air travel, RevPAR, and employment.
- Identify trends in seasonal variations and their influence on tourism and local businesses.
- Develop predictive models to support decision-making for rapid recovery and future crisis management.
- Provide stakeholders with a data-driven framework for improving economic stability and preparedness.

2.Planning Phase

a. Methodology

Data Sources and Collection

- **Tourism Metrics:** Occupancy Rate, Average Daily Rate (ADR), and RevPAR data were sourced from Hawaii's tourism authority and industry reports.
- **Employment Data:** Historical job trends in accommodation, food services, and government sectors were gathered from state employment databases.
- **Disaster Data:** FEMA disaster declarations, including incident types and their timeframes, were analyzed to quantify impacts.
- **Visitor Expenditures and Air Travel:** Data on visitor spending and air travel volumes were collected from publicly available tourism statistics.

Tools and Techniques Used

Data Cleaning and Transformation

- **Tools Used: Python (Pandas, NumPy), Excel.**
- **Approach:** Merged multiple datasets, including historical disaster records, tourism metrics (e.g., occupancy rates, ADR, air travel data), and employment trends. This unified dataset allowed for comprehensive analysis; Standardized month and year data for consistency; Handled missing values and created disaster indicators for analysis.
- **Why:** These tools were ideal for handling large datasets with missing or inconsistent values, providing precision and flexibility.

Exploratory Data Analysis (EDA)

- **Tools Used;** Used Python (Pandas, Matplotlib, Seaborn) for initial trend analysis and correlation heatmaps.
- **Approach:** Visualized key metrics over time to identify trends, seasonality, and disruptions caused by disasters. For instance, we analyzed year-over-year changes to account for seasonal patterns.
- **Why:** Visualization helped identify patterns that statistical analysis alone might miss, such as the varying impacts of different disasters across counties.

Predictive Modeling

- Linear Regression to quantify relationships between metrics and jobs.
- Time Series Forecasting (ARIMA, Exponential Smoothing) for predicting trends in tourism and employment.

Tools Explored but Not Used

- **Advanced Machine Learning Models (Random Forests, Neural Networks)**:

- **Why They Didn't Work**:
  - High complexity made results less interpretable for non-technical stakeholders.
  - County-level data granularity was insufficient for these models to perform effectively.
- **What We Expected**: These models were initially considered to capture complex relationships and patterns but proved less practical given stakeholder priorities and available data.

Analytical Framework

Data Preparation

- Cleaned and merged tourism, employment, and disaster datasets into a unified time-series format.

EDA

- Identified trends, correlations, and outliers in key metrics.

Regression Analysis

- Quantified the impact of Occupancy Rate, ADR, and Air Travel on accommodation jobs.

Forecasting Models

- Predicted future trends in employment and tourism metrics using historical data.

Key Insights and Recommendations

- Synthesized findings into actionable strategies for disaster recovery and resilience planning.

4. Execution Phase

a. Exploratory Data Analysis (EDA)

Overview of Key Metrics

Tourism Metrics

- Occupancy Rate Statewide: Indicator of tourism demand; a key driver for accommodation jobs.
- Average Daily Rate (ADR): Reflects hotel pricing strategies; influences demand and revenue.
- RevPAR (Revenue Per Available Room): Combines occupancy and ADR to measure hotel performance.
- Air Travel (Statewide): Represents tourist inflows; closely linked to accommodation and food service jobs.
- Visitor Expenditures: Captures economic contributions of air travelers.

Employment Metrics

- Accommodation Jobs: Strongly tied to tourism activity and seasonality.
- Food Services Jobs: Influenced by tourist spending and local demand.
- Government Jobs: Stable across disaster and non-disaster periods, providing economic resilience.

Disaster Metrics

- Incident Types: Hurricanes, floods, biologic, and volcanic eruptions impact tourism metrics and jobs.
- Declaration Types (FM, DR, EM): Used to identify periods of significant disruption.

Trends and Insights from Data

Tourism Trends

- Clear seasonality observed in Occupancy Rate and Air Travel, with peaks in December and March.
- ADR shows slight increases during high-demand periods but negatively correlates with jobs.

Employment Trends

- Accommodation Jobs fluctuate significantly during disasters and seasonal peaks.
- Food Services Jobs closely align with visitor expenditures and occupancy rates.
- Government Jobs remain stable, highlighting their resilience.

Disaster Impacts

- Significant declines in Occupancy Rate and Accommodation Jobs during disaster periods.
- Air Travel experiences sharp drops, leading to cascading effects on tourism-related sectors.

Correlation Insights

- Strong positive correlation between Occupancy Rate and Accommodation Jobs.
- Weak correlation between Visitor Expenditures and job metrics, suggesting other drivers at play.

b. Time Series Forecasting

- **Methodology and Approach**

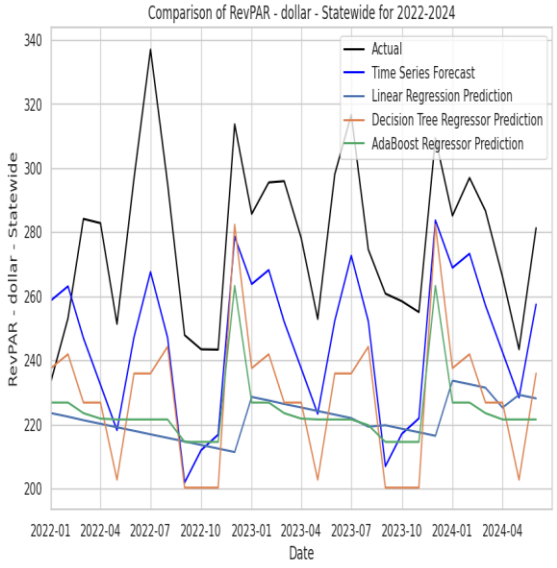
In this analysis, **Exponential Smoothing** was used for time series forecasting. This method is well-suited for predicting future values of key economic indicators, as it captures both **seasonality** and **trends** in the data. The metrics that were forecasted included:

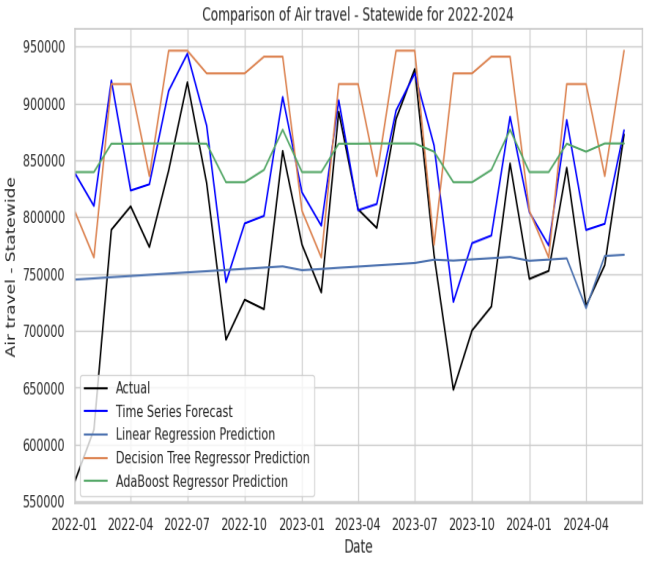
- **Occupancy Rate**
- **Average Daily Rate (ADR)**
- **Revenue per Available Room (RevPAR)**
- **Air Travel**

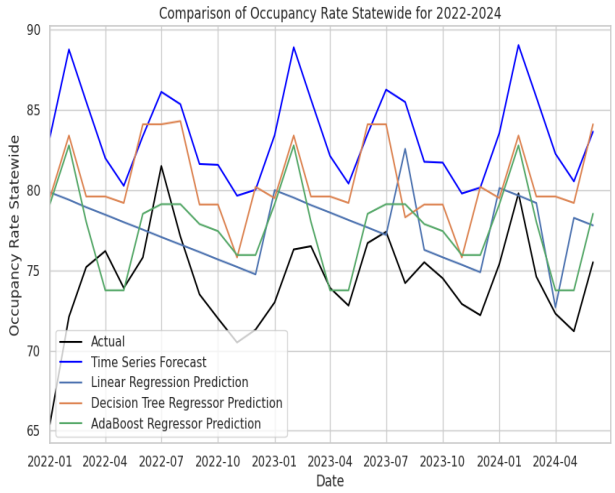
The forecasts were made for the period from **2022 to 2024** using the cleaned and merged dataset, which included hotel performance, air travel data, and disaster-related information. This allowed for a comprehensive understanding of future trends in the context of historical data.

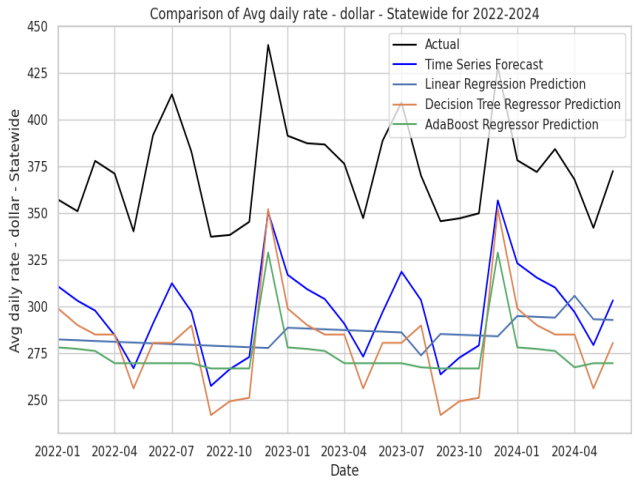
- **Results and Forecasting Performance**

The performance of the forecasts was evaluated by comparing the predicted values against actual data. This helped assess how well the model captured seasonality and trends in the economic indicators. The **Exponential Smoothing** model provided reasonable accuracy, particularly in the **Occupancy Rate**, but there was some deviation in the forecasts for **ADR** and **Air Travel**.


Comparison of RevPAR - dollar - Statewide for 2022-2024
RevPAR - dollar - Statewide
Date
Actual
Time Series Forecast
Linear Regression Prediction
Decision Tree Regressor Prediction
AdaBoost Regressor Prediction


Comparison of Air travel - Statewide for 2022-2024
Air travel - Statewide
Date
Actual
Time Series Forecast
Linear Regression Prediction
Decision Tree Regressor Prediction
AdaBoost Regressor Prediction


Comparison of Occupancy Rate Statewide for 2022-2024
Occupancy Rate Statewide
Date
Actual
Time Series Forecast
Linear Regression Prediction
Decision Tree Regressor Prediction
AdaBoost Regressor Prediction


Comparison of Avg daily rate - dollar - Statewide for 2022-2024
Avg daily rate - dollar - Statewide
Date
Actual
Time Series Forecast
Linear Regression Prediction
Decision Tree Regressor Prediction
AdaBoost Regressor Prediction

c. Regression Analysis

- **Model Selection and Evaluation**

Three regression models were chosen to explore the relationship between economic outcomes and disaster events:

- **Linear Regression**: A simple approach to identify linear relationships.
- **Decision Tree Regressor**: A more complex model capable of capturing non-linear relationships.
- **AdaBoost Regressor**: An ensemble method designed to improve performance through boosting.

Each of these models was trained using key features from the dataset, such as **disaster type** (e.g., fire, flood, hurricane) and economic metrics like **occupancy rate**, **ADR**, **RevPAR**, and **air travel**.

Performance Metrics (MSE, MAE, R^2)

To evaluate the models, we used the following metrics:

- **Mean Squared Error (MSE)**: Measures the average squared difference between predicted and actual values, helping assess the model's error.
- **Mean Absolute Error (MAE)**: Measures the average absolute difference between predicted and actual values, providing insight into the model's accuracy.
- **R-Squared (R^2)**: Represents how well the model fits the data. A higher R^2 indicates a better fit.

Model Comparison (Linear Regression, Decision Tree, AdaBoost)

- **Linear Regression** showed poor performance, with a negative **R^2** indicating a poor fit to the data. The model was unable to capture the complex relationships between the features.
- **Decision Tree Regressor** performed better than **Linear Regression**, but it was prone to **overfitting**, especially for metrics like **RevPAR** and **Occupancy Rate**.
- **AdaBoost Regressor** performed the best overall, with the **lowest MSE** and **MAE** values, and the highest **R^2** scores for **Occupancy Rate**, making it the most reliable model for forecasting.

d. Key Metrics and Insights from Model Analysis

- **Occupancy Rate**: **AdaBoost Regressor** was the most effective model, yielding the lowest **MSE** and **MAE**. The model's accuracy was further enhanced by boosting techniques, making it the most reliable predictor.

- **ADR**: All models struggled to predict **ADR**, showing high **MSE** and **MAE** values. This suggests that **ADR** is influenced by factors not captured in the dataset.
- **RevPAR**: **AdaBoost** showed slight improvement over other models, but the $\mathbf{R^2}$ values remained low, indicating that the models struggled to fully capture the variance in **RevPAR**.
- **Air Travel**: All models performed poorly, suggesting that **Air Travel** is influenced by external factors (e.g., economic policies, international events) that were not included in the dataset.

Impact of Disasters on Economic Indicators (Hotel Metrics, Air Travel)

Impact of Disasters on Economic Indicators

The analysis examined how different types of **disasters** (e.g., fire, flood, hurricane) impacted key **hotel performance metrics** and **air travel**. Using the **regression models**, we found that:

- **Occupancy Rate**: Disasters tend to significantly affect hotel occupancy. However, the impact varies depending on the disaster type, with some models predicting higher occupancy post-disaster, likely due to increased emergency accommodations.
- **Average Daily Rate (ADR)**: The effect of disasters on **ADR** was less clear. The models performed poorly in predicting **ADR**, suggesting that external factors beyond disaster events may influence hotel pricing.
- **RevPAR**: Like **ADR**, the impact of disasters on **RevPAR** was weak, with **AdaBoost** showing marginally better performance in predicting this metric, though the models generally underperformed.
- **Air Travel**: Disasters were found to have a more pronounced effect on **air travel** in some cases, particularly with **hurricanes** or large-scale events. However, the **MSE** and **MAE** values indicated that **air travel** was influenced by a wider set of variables not captured by the current dataset.

Target-Wise Analysis (Occupancy Rate, ADR, RevPAR, Air Travel)

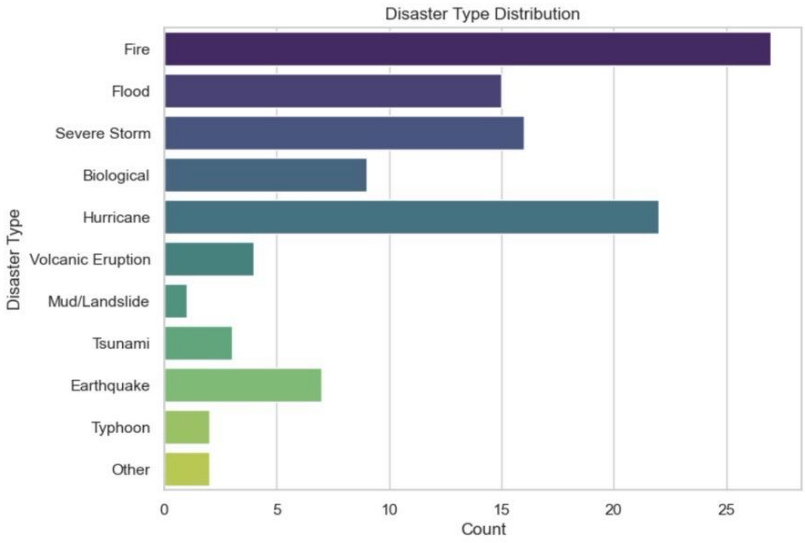
Each metric was analyzed with respect to its sensitivity to disaster events:

- **Occupancy Rate**: The **AdaBoost** model provided the most accurate predictions for **Occupancy Rate**, suggesting that disasters have a measurable impact on hotel demand.
- **ADR**: The models struggled to capture the variation in **ADR**, indicating that external economic factors (beyond disasters) are likely influencing hotel pricing strategies.
- **RevPAR**: **AdaBoost** again showed slight improvements, but overall, the relationship between **RevPAR** and disasters remained unclear due to the low predictive power of the models.
- **Air Travel**: Like **ADR** and **RevPAR**, **Air Travel** was impacted by external variables not included in the dataset, leading to underperformance by all models.

e. FEATURE IMPORTANCE

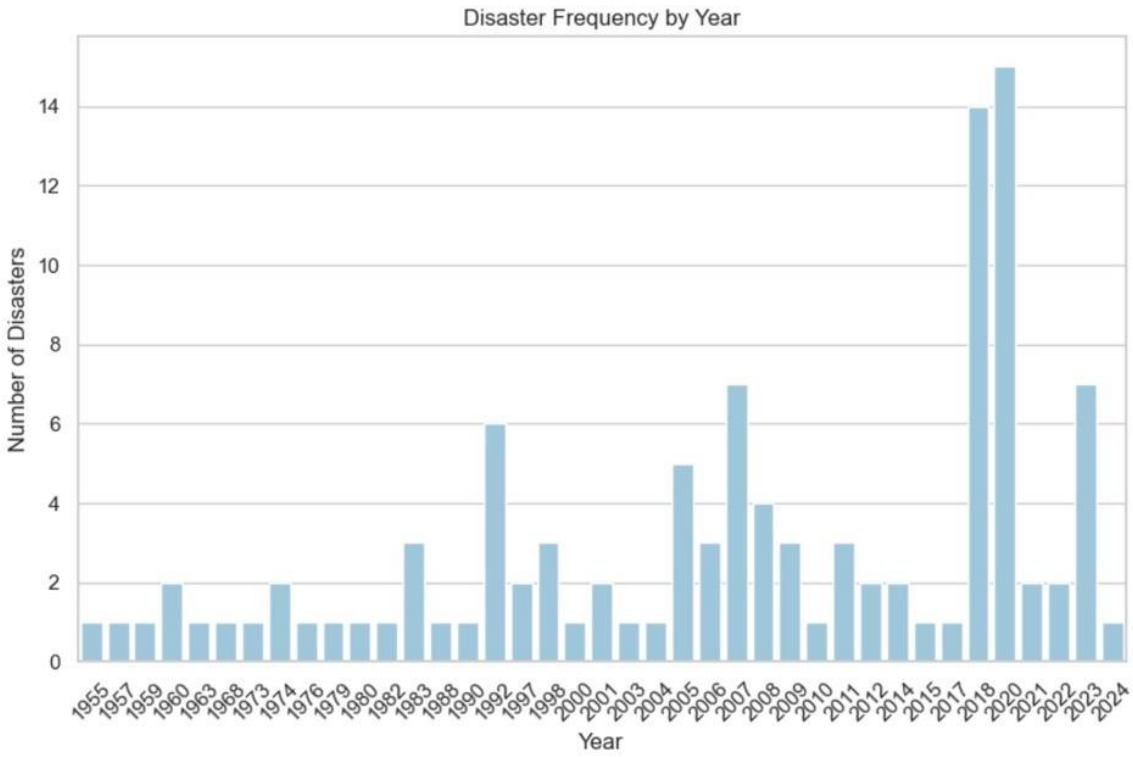
Disaster Distribution

- Always being ready and taking measures to lessen the impact of the most common disasters fires, floods, and severe storms is essential.
- Tactical responses are necessary for less frequent events, such as hurricanes and biological incidents, while specialized planning is necessary for rare but cataclysmic calamities, such as volcanic eruptions and tsunamis.
- Knowing how these resources are distributed helps plan for high-impact events while allocating resources for regular disasters.



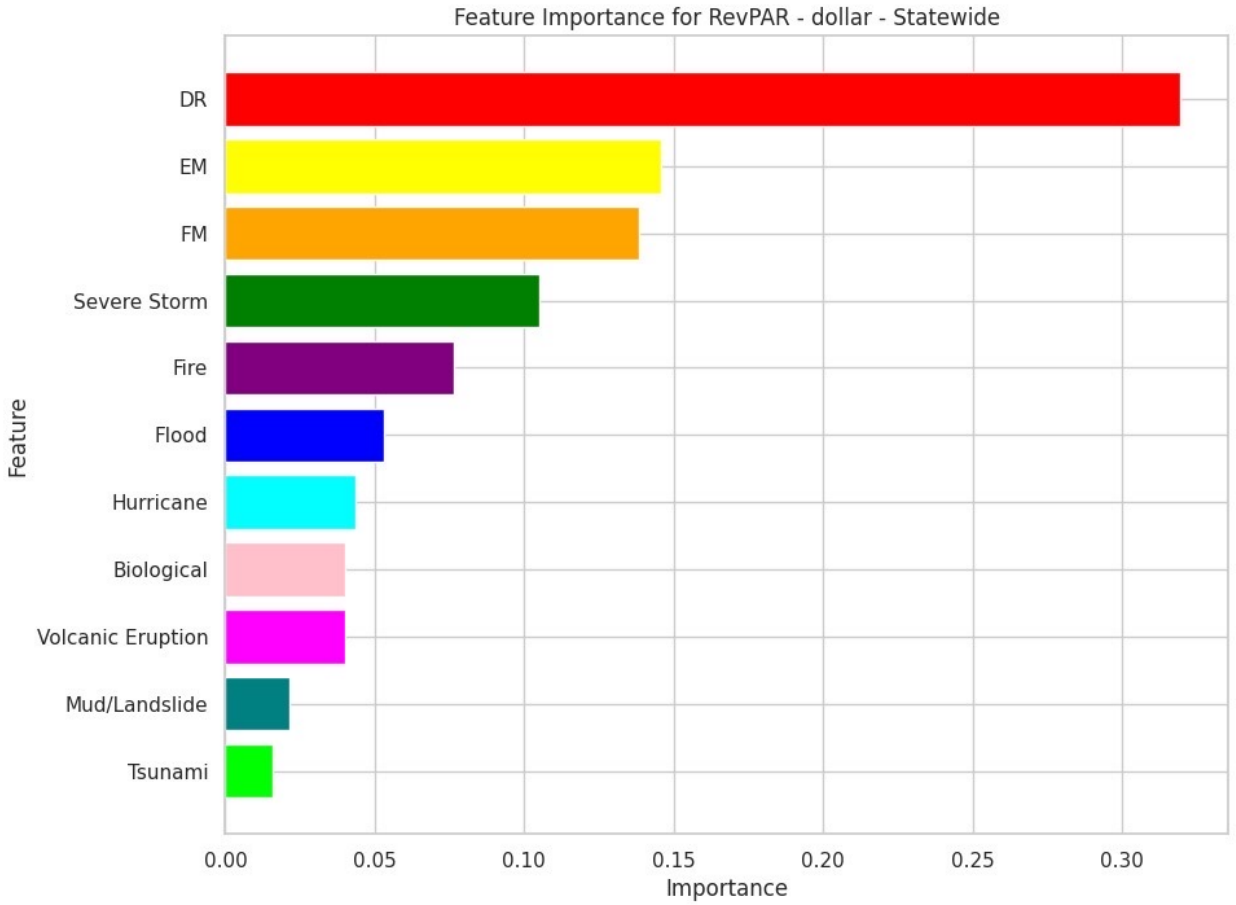
Disaster Frequency

- In recent years, the number of disasters has gone up, with peaks between 2018 and 2020. This could be because disasters are getting worse or because people are reporting them better.
- There may have been gaps in the statistics in earlier years when fewer events were logged. Finding trends can help you predict future risks and make good use of your resources. This makes it even more important to have crisis response systems that are flexible and scalable.



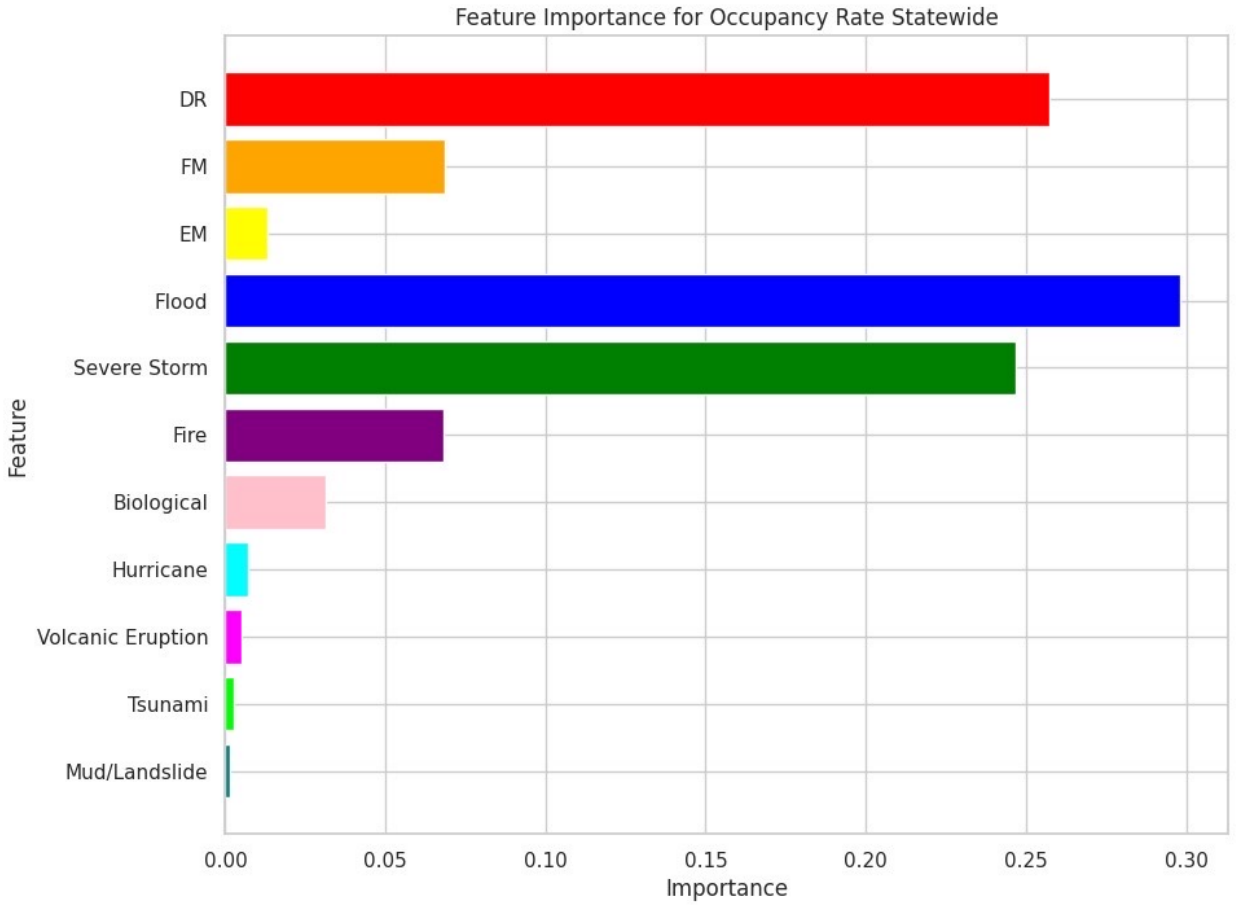
RevPAR

- Revenue per available room (RevPAR) is most affected by state-wide major disaster declarations (DR), which highlight the enormous disruption that large-scale catastrophes bring.
- Declarations of Emergency (EM) and Declarations of Fire Management Assistance (FM) are also extremely important, as they highlight the significance of prompt involvement in order to minimize the number of economic damages.
- The repercussions of hurricanes, biological catastrophes, and tsunamis are less widespread, perhaps because of their limited nature, compared to severe storms and fires, which have considerable impacts. These results emphasize the need for strong recovery and reaction plans to keep lost income to a minimum.



Occupancy Rate

- Significant Disaster Declarations (DR) have the greatest impact on state-wide occupancy rates, which is a reflection of the extensive disruption that significant disasters generate.
- Occupancy is greatly impacted by infrastructure damage caused by floods and severe storms, but one way to mitigate this is by prompt emergency declarations and fire management plans.
- Biological events and hurricanes have smaller effects, which suggests that their effects are more concentrated. The study shows how important it is for disaster relief attempts to keep people living in their homes while they wait for repairs to be made.



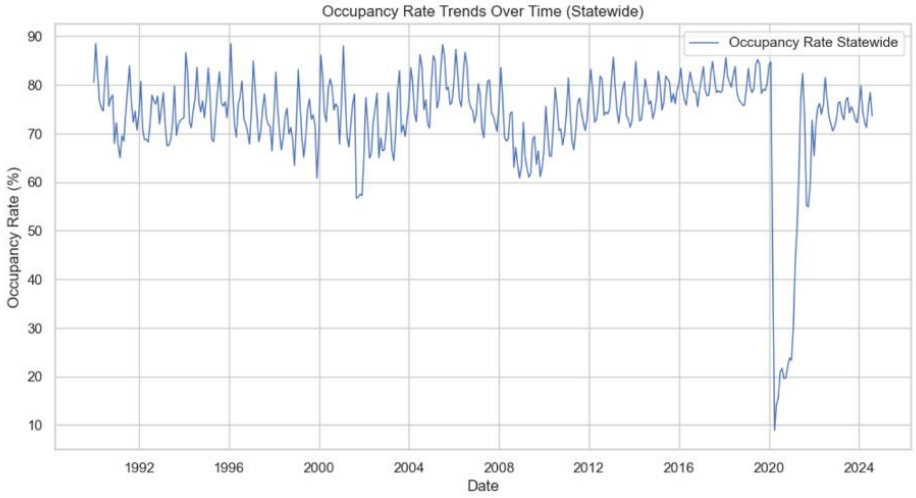
5.KEY FINDINGS OF TOURISM AND EMPLOYMENT METRICS

Statewide Analysis of Tourism Metrics

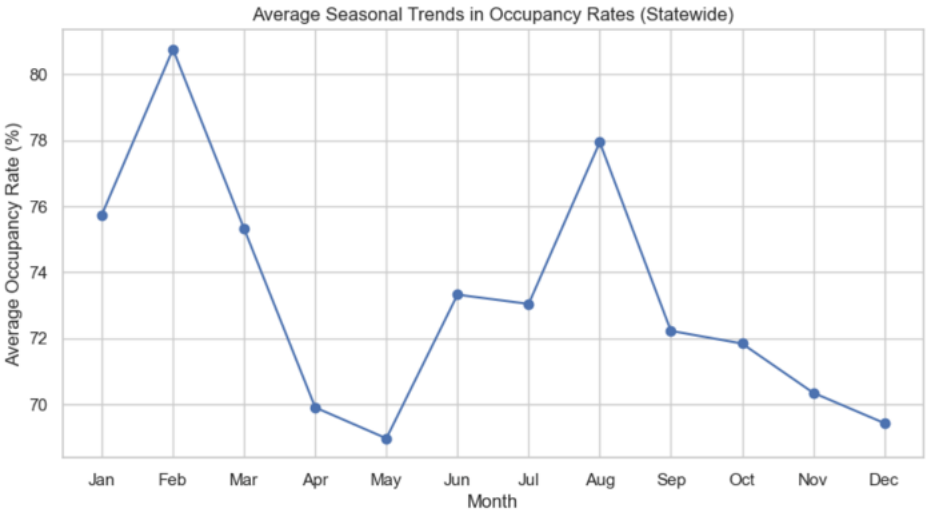
1. Occupancy Rate

- **Historical Consistency**: From the early 1990s to just before the COVID-19 pandemic in 2020, Hawaii's occupancy rates largely stayed between 70% and 85%. This consistency indicates steady tourism demand and a stable market for hospitality services.
- **Seasonal Fluctuations**: There's a recurring pattern where occupancy fluctuates seasonally, likely peaking during tourist-heavy seasons (like summer) and dipping during off-peak months.
- **Impact of COVID-19**: Around 2020, there's a dramatic drop, which is consistent with the impact of the COVID-19 pandemic. Occupancy rates plunged as travel restrictions and health concerns severely impacted tourism.

- **Recovery**: The chart shows a relatively rapid bounce-back after this drop, with occupancy rates quickly returning to pre-pandemic levels. However, post-pandemic stability may still be fluctuating as tourism fully recovers.



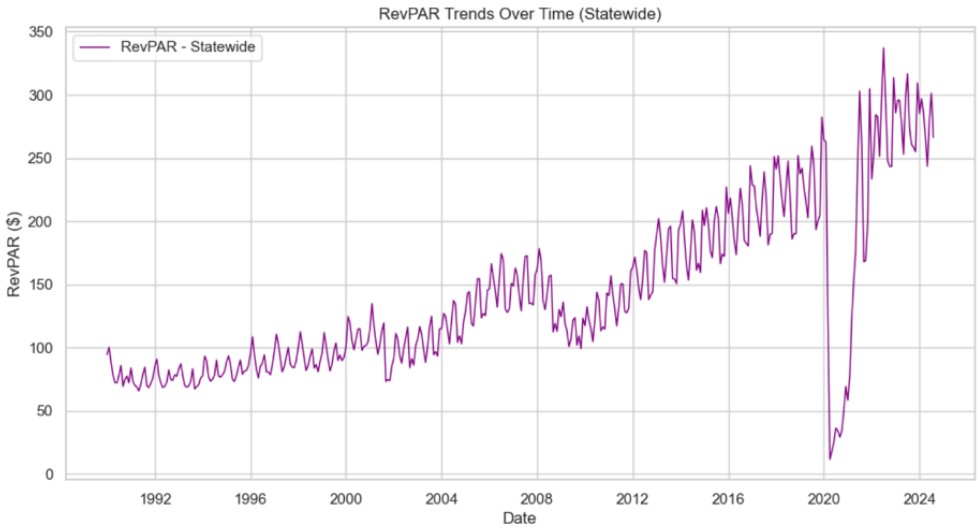
- **Average Seasonal Trends in Occupancy Rates:**February and July show spikes, likely due to Winter vacations and Summer peak travel.December shows a sharp drop, indicating fewer bookings at the start of the holiday season before a rise in RevPAR.Months like June and October reflect a rebound phase, where occupancy begins to climb after preceding lows.Adjusting marketing campaigns to encourage travel during low-occupancy months like December and October and monitoring external factors (e.g., weather, holidays) that influence occupancy rates are key strategic insights that can be drawn from the chart below.



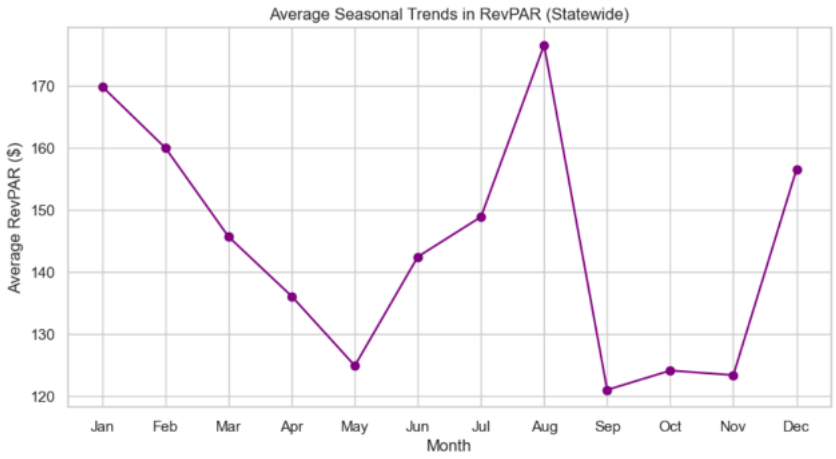
2. RevPAR (Revenue Per Available Room)

- **Long-Term Growth**: From the 1990s onward, we see a steady increase in RevPAR, suggesting that room revenue has grown over time, potentially driven by increasing daily rates and demand.

- **Sharp Decline and Recovery**: Similar to the occupancy rate, there's a significant drop in RevPAR around 2020, again due to the pandemic's impact on the tourism sector. Following this, there's a swift recovery with RevPAR reaching new highs, possibly as hotels increased rates to meet demand or cover operational costs.
- **Post-Recovery Volatility**: The RevPAR line post-pandemic shows more pronounced fluctuations. This could reflect shifting pricing strategies, dynamic demand adjustments, and changing travel patterns.

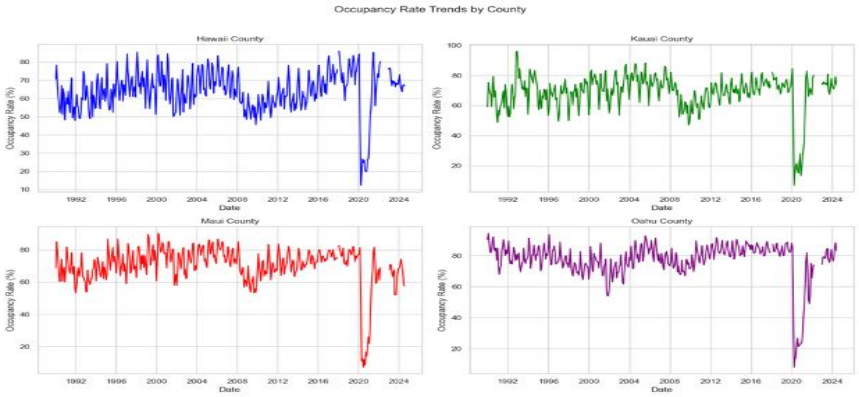


- **Average Seasonal Trends in RevPAR (Statewide):**Notable peaks in January and August suggest high tourism demand during these months, likely due to Winter tourism in January and Summer vacations (August).May and September show significant dips, likely reflecting shoulder seasons or lower tourist activity.RevPAR closely aligns with the influx of tourists and hotel pricing strategies.The sharp increase toward December aligns with holiday season travel, boosting both demand and pricing.Hotels can optimize pricing during peak months (January, August, December) to maximize revenue. Marketing efforts might focus on improving bookings during low periods like May and September.



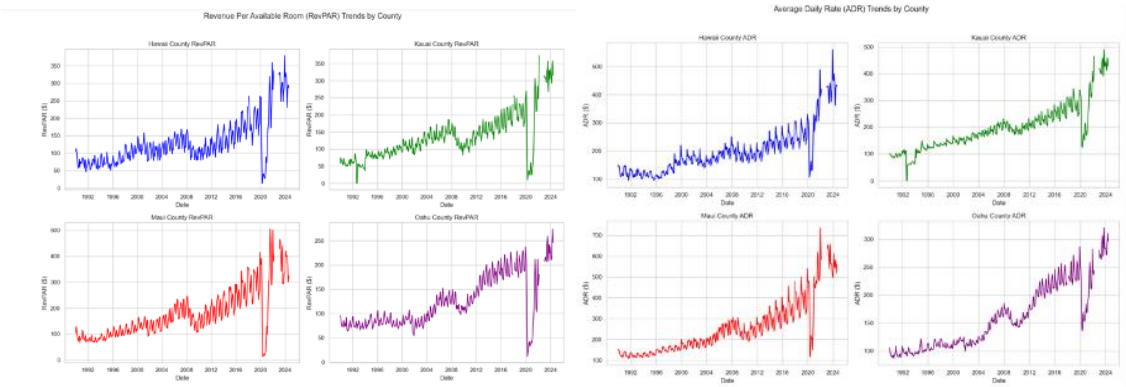
County-Wide Analysis of Tourism Metrics

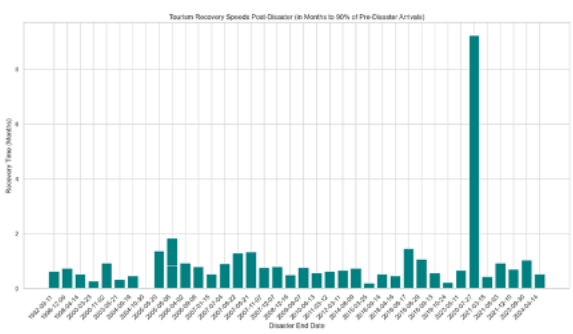
1. **Occupancy Rates:** As we compare occupancy rates, there are clear disparities in how quickly each county returns to baseline levels. For example:
   - **Oahu**—the most popular island for tourists—displays a relatively faster return to pre-disaster levels compared to more remote islands like **Hawaii Island** and **Kauai**. This faster recovery might be due to its infrastructure resilience and diversified tourism market.
   - **Kauai** and **Hawaii Island**, however, show delayed recoveries in certain disaster periods, which could indicate vulnerabilities in their dependence on specific travel segments or logistical challenges in attracting visitors post-disaster.

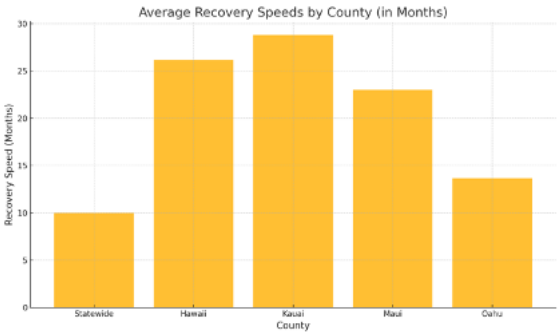


By visually representing these recovery trends, we're not just identifying vulnerabilities but also pinpointing areas where targeted support might accelerate recovery in future scenarios."

2. **ADR & RevPAR:**Switching to ADR and RevPAR, these metrics shed light on economic recovery. The Average Daily Rate (ADR) indicates pricing resilience, while RevPAR, combining occupancy and ADR, offers a complete picture of revenue recovery.Our analysis finds that:
   - **Oahu's ADR** remained relatively stable even during disaster periods, suggesting strong pricing power and a consistent value proposition for tourists.
   - Conversely, **Maui's ADR and RevPAR** exhibit volatility, possibly due to greater sensitivity to changes in occupancy and demand. From a strategic perspective, this analysis is invaluable for policymakers and businesses alike. Identifying which counties have stable ADRs during crises can inform pricing strategies for future events, potentially sustaining revenue even during downturns

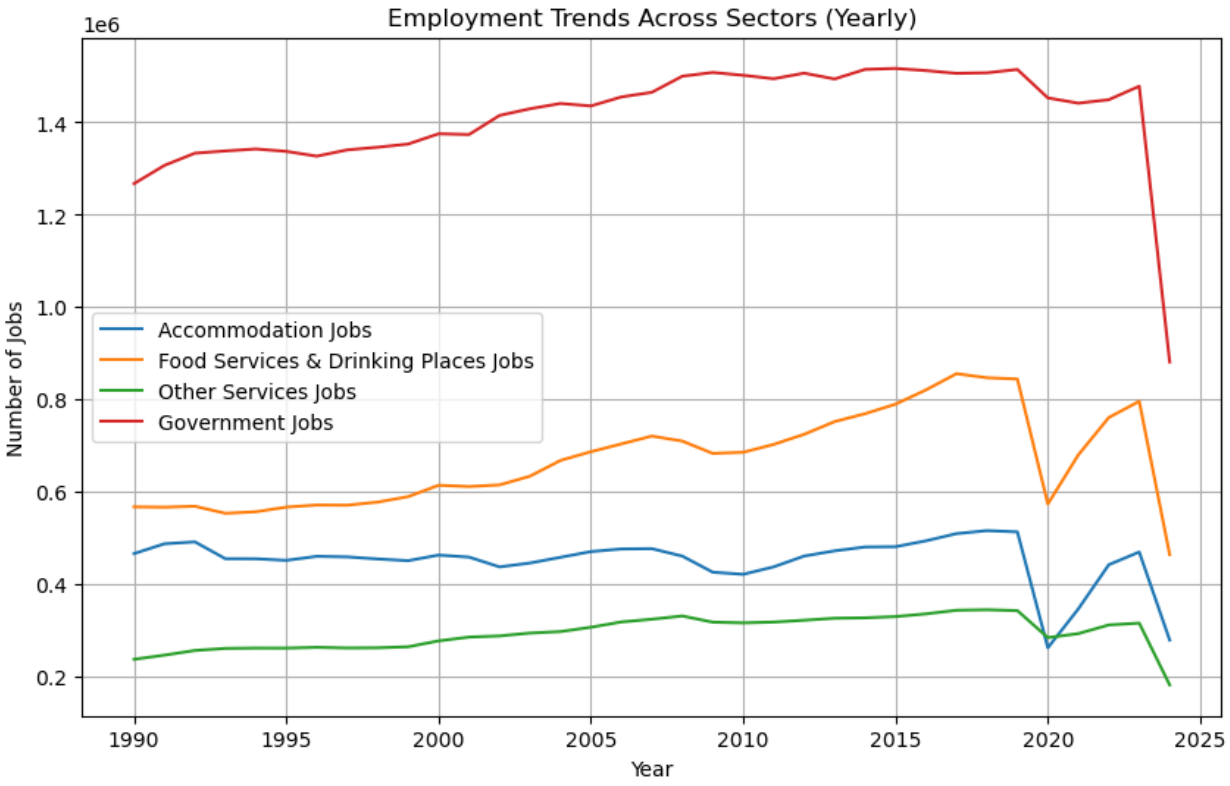




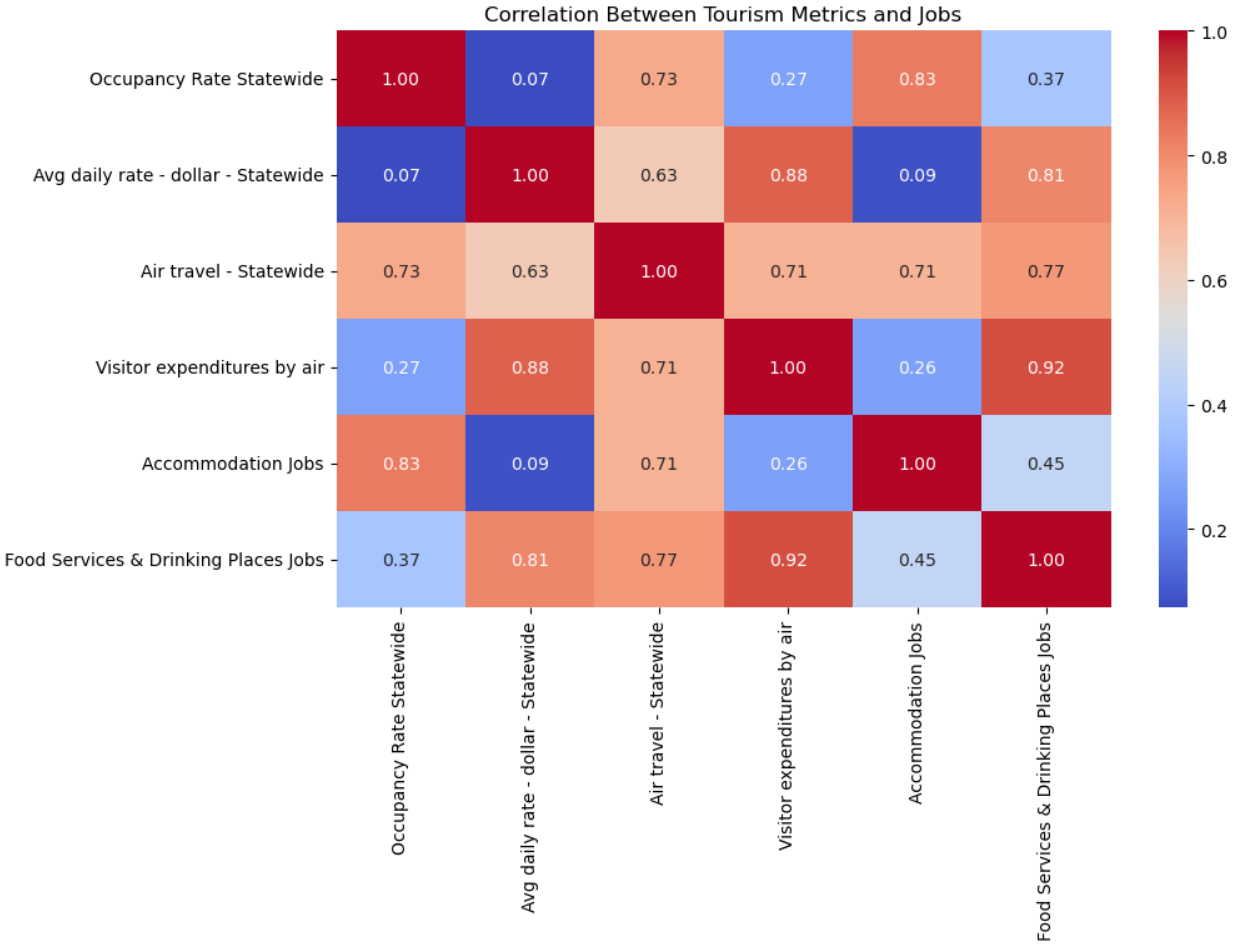


Statewide Analysis of Employment Metrics

1) Yearly Employment Trends Across Sectors (Statewide) (add graph here):The line chart below highlights the trends in employment across key sectors, including Accommodation, Food Services, Other Services, and Government jobs, from 1990 to 2025. Government jobs demonstrate long-term stability, maintaining a consistent upward trend, even during economic and disaster disruptions. In contrast, Accommodation and Food Services jobs show notable declines, particularly in 2020, coinciding with pandemic-related impacts on the tourism sector. The steep decline in 2020 aligns with external shocks, such as the COVID-19 pandemic, underscoring the vulnerability of these sectors to economic disruptions

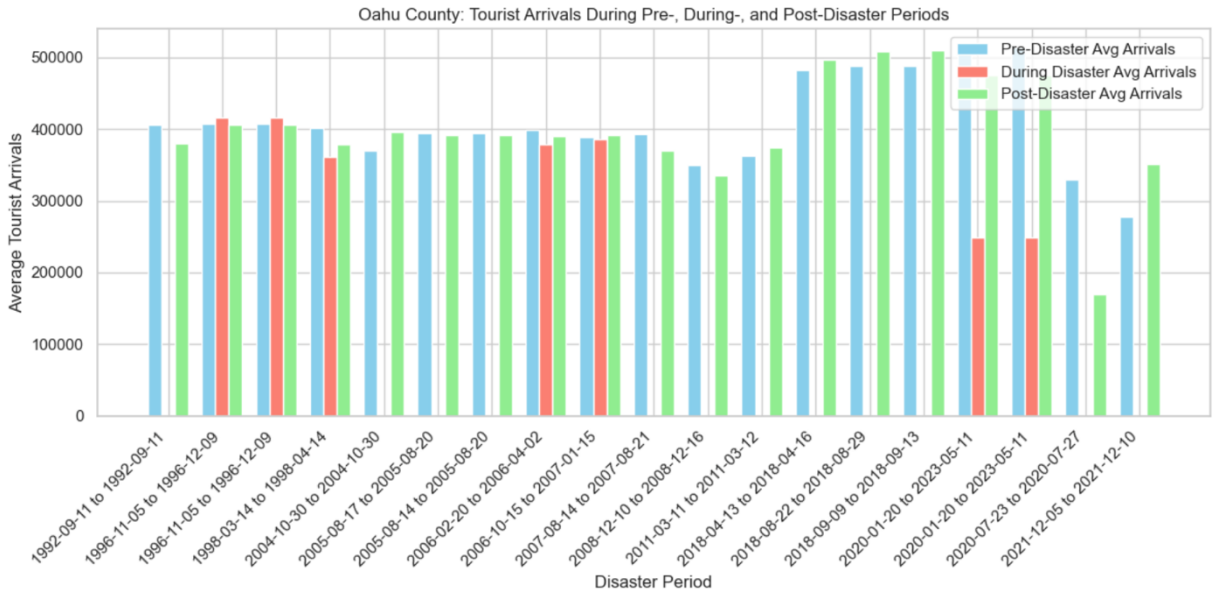


2) **Correlations Between Tourism Metrics and Jobs:** A correlation analysis was conducted between tourism metrics and job sectors, focusing on Occupancy Rate, Air Travel, Visitor Expenditures, and employment in Accommodation and Food Services which confirms the reliance of Accommodation and Food Services jobs on tourism-related metrics, reinforcing the need for policies that stabilize these metrics during disruptions. Occupancy Rate and Air Travel exhibit strong positive correlations with Accommodation Jobs (0.83 and 0.71, respectively), highlighting the direct dependency of job creation on tourism activity.Visitor expenditures are highly correlated with Food Services jobs (0.92), emphasizing the significant link between tourist spending and employment in the sector.


Correlation Between Tourism Metrics and Jobs
Occupancy Rate Statewide
Avg daily rate - dollar - Statewide
Air travel - Statewide
Visitor expenditures by air
Accommodation Jobs
Food Services & Drinking Places Jobs
1.00 0.07 0.73 0.27 0.83 0.37
0.07 1.00 0.63 0.88 0.09 0.81
0.73 0.63 1.00 0.71 0.71 0.77
0.27 0.88 0.71 1.00 0.26 0.92
0.83 0.09 0.71 0.26 1.00 0.45
0.37 0.81 0.77 0.92 0.45 1.00
1.0
0.8
0.6
0.4
0.2

Countywide Analysis of Impact of Disasters on Tourist Arrivals

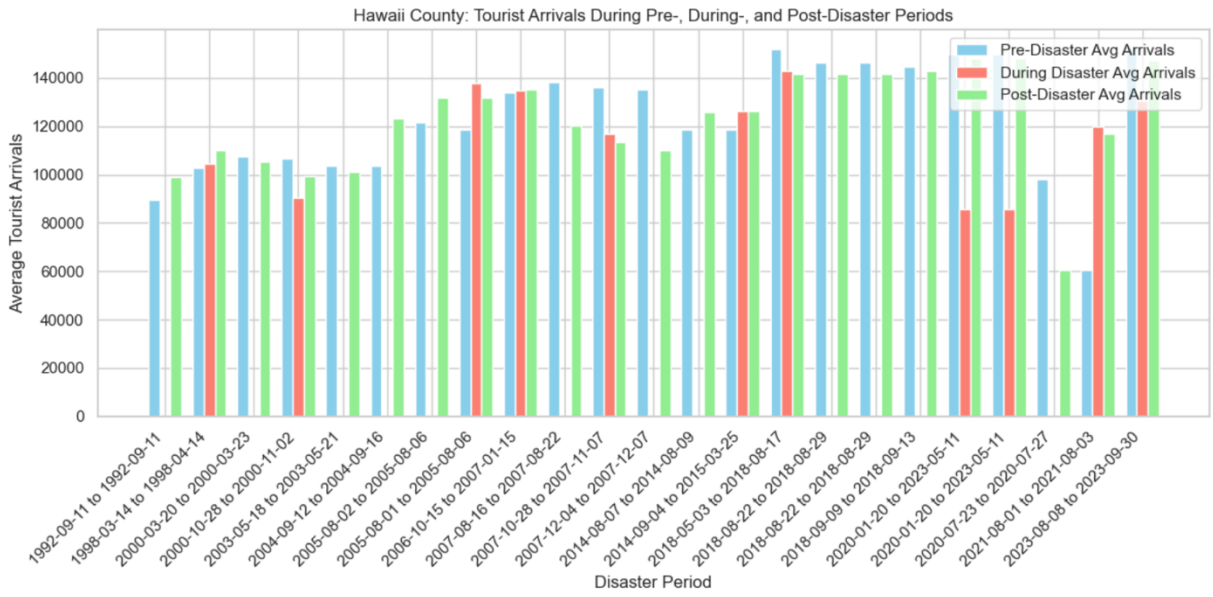
1) **Oahu County:** Oahu County consistently shows the highest average tourist arrivals among all Hawaiian counties, highlighting its central role in Hawaii's tourism industry. However, disasters significantly impact tourist numbers, as seen in the sharp declines during disaster periods (red bars).
    a. **Key Observations**
        i. **Pre-Disaster Periods:**Average tourist arrivals remain consistently high, reflecting the strong appeal of Oahu's attractions and its role as a key entry point for international and domestic travelers.
        ii. **During Disaster Periods:**Tourist arrivals show a notable decline during disasters, with the extent varying based on the severity and duration of the event. Recent disasters, such as the COVID-19 pandemic, caused particularly steep drops, exacerbated by global travel restrictions.
        iii. **Post-Disaster Periods:**Recovery trends are robust, with tourist arrivals often surpassing pre-disaster levels, indicating effective post-disaster recovery efforts and sustained demand for Oahu's offerings.However, the recovery trajectory varies depending on the nature of the disaster. Events with prolonged effects tend to exhibit slower recovery.



2) Hawaii County: Hawaii County demonstrates a dynamic pattern of tourist arrivals before, during, and after disaster periods, showcasing both the vulnerabilities of its tourism sector and its ability to recover.
    a. Key Observations
        i. **Pre-Disaster Periods:**Average tourist arrivals before disasters are relatively high, indicating steady tourism demand driven by Hawaii County's natural attractions and cultural significance.

ii. **During Disaster Periods:**Tourist arrivals decline sharply during disasters, reflecting the immediate impact on visitor confidence and accessibility. The magnitude of decline varies across events, with some disasters causing more pronounced drops than others.

iii. **Post-Disaster Periods:**Post-disaster recovery is evident, with arrivals frequently returning to or exceeding pre-disaster levels. This indicates successful recovery efforts and the resilience of Hawaii County's tourism sector. In some instances, the recovery period shows a gradual upward trend, reflecting the effectiveness of marketing campaigns and infrastructure repairs.



3) Kauai County: Kauai County is known for its pristine natural beauty and appeal as a tourist destination, displays notable fluctuations in tourist arrivals during disaster periods. These variations underscore both its sensitivity to external disruptions and its gradual recovery capabilities.

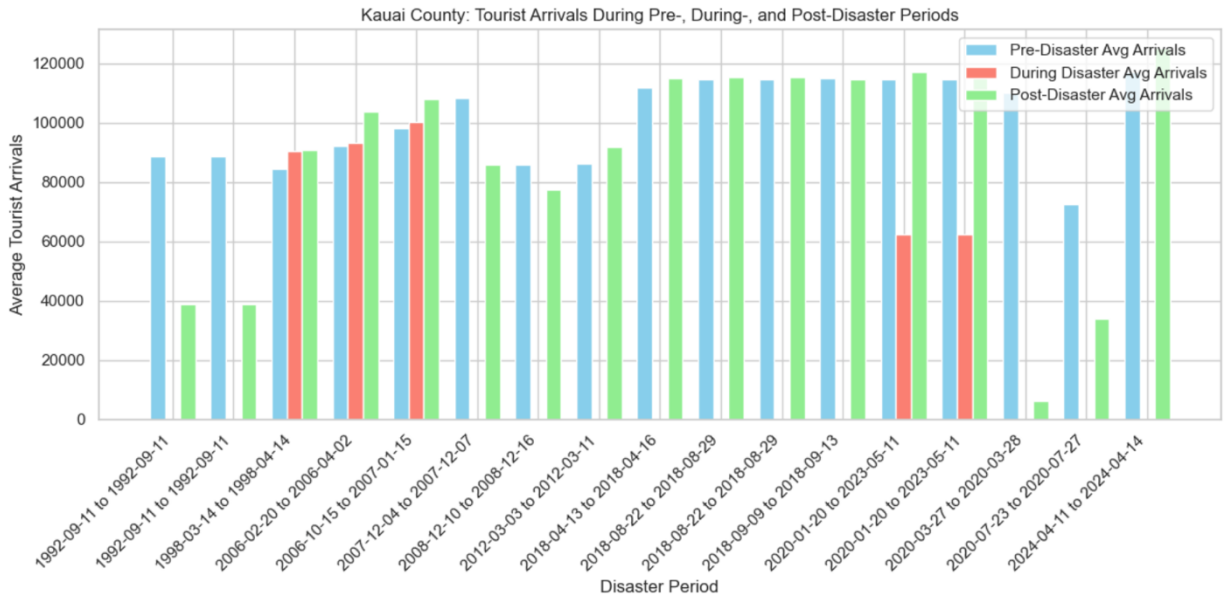
a) Key Observations

i. **Pre-Disaster Periods:**Tourist arrivals are relatively stable and moderately high, indicating steady demand for Kauai's unique attractions, such as the Napali Coast and Waimea Canyon.

ii. **During Disaster Periods:**The county experiences significant declines in tourist arrivals during disasters, with some events causing sharp and prolonged drops. This indicates a high level of vulnerability, likely due to its dependence on tourism and limited infrastructure to handle disaster impacts.

iii. **Post-Disaster Periods:**Recovery trends vary, with some disasters showing rapid rebounds in arrivals, while others exhibit slower and incomplete recovery.For certain disaster periods, post-disaster tourist

numbers do not fully return to pre-disaster levels, reflecting either lingering effects of the event or slower recovery efforts.



4) Maui County: Impact of Disasters on Tourist Arrivals: Maui County, a popular destination for its beaches, luxury resorts, and cultural experiences, exhibits a strong and resilient tourism sector. Despite the disruptions caused by disasters, Maui consistently demonstrates robust recovery trends.

a) **Key Observations:**

i. **Pre-Disaster Periods:**Maui maintains consistently high tourist arrivals prior to disasters, reflecting its enduring appeal and status as a premier vacation destination.

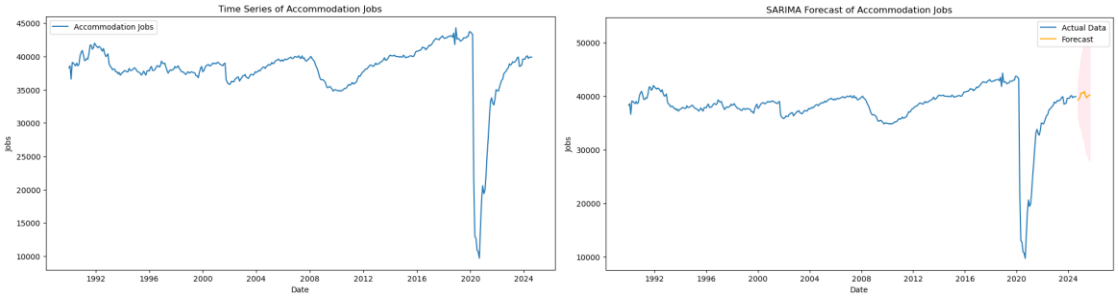
ii. **During Disaster Periods:**Disasters lead to noticeable declines in tourist arrivals, although the drops are generally less severe compared to other counties, indicating the county's ability to retain some level of tourism activity during crises.The extent of the decline varies, with larger impacts observed during widespread disasters like the COVID-19 pandemic.

iii. **Post-Disaster Periods:**Post-disaster recovery in Maui is consistently strong, with tourist arrivals often exceeding pre-disaster levels. This highlights the county's effective recovery strategies, robust tourism infrastructure, and strong market demand.The rapid recovery in several cases underscores Maui's reputation as a resilient and adaptable tourism hub.

6. Forecasting

Accommodation Jobs Forecast

The first graph illustrates the trend in accommodation jobs from 1990 to 2024. The data exhibits seasonal fluctuations and significant dips, particularly during the COVID-19 pandemic in 2020, followed by a recovery period. On the other hand, the second graph presents the SARIMA model's forecast for accommodation jobs. The model predicts a slight upward trend post-2024, with a confidence interval (shaded region) highlighting uncertainty in future estimates. This demonstrates the model's ability to capture recent trends and provide plausible future projection



7.CLOSING PHASE

A) Recommendations to Stakeholders and Execution Teams

I)Stakeholders

Disaster Preparedness and Mitigation

- Implement Contingency Plans: Develop targeted policies to protect accommodation jobs during disasters (e.g., hurricanes, pandemics) by offering wage subsidies, temporary unemployment benefits, and business relief funds.
- Infrastructure Resilience: Strengthen physical infrastructure to reduce the disruption caused by natural disasters, ensuring continued operations in critical sectors like accommodations and tourism.

Tourism Demand Management

- Diversify Revenue Streams: Promote less seasonally dependent tourism activities (e.g., cultural events, eco-tourism) to stabilize job demand and mitigate the impact of seasonal fluctuations.
- Strategic Marketing Campaigns: Focus on attracting international travelers during off-peak seasons to maintain job levels across the year, as SARIMA forecasts show minimal short-term recovery without intervention.

Workforce Development and Support

- Upskilling Programs: Provide training programs for workers in the accommodation sector to transition into complementary roles during disaster periods, ensuring employment continuity.
- Flexible Job Models: Encourage part-time or gig-based employment to adapt to fluctuating demand while maintaining a steady income source for affected workers.

Policy Adjustments for Economic Stability

- Tax Incentives for Employers: Offer temporary tax relief or grants to businesses in the accommodation and food services sectors during periods of economic downturn.
- Enhanced Recovery Funding: Allocate dedicated funding to assist small and medium enterprises (SMEs) in the tourism industry, ensuring their ability to rehire workers post-disruption.

Data-Driven Decision-Making

- Leverage Predictive Models: Utilize forecasting tools like SARIMA to anticipate job trends and allocate resources effectively, especially in preparation for seasonal and disaster-driven declines.

- Continuous Monitoring: Establish systems for regular tracking of tourism and employment metrics (e.g., occupancy rate, air travel, visitor spending) to identify emerging risks and opportunities.

Collaboration with Industry Stakeholders

- Public-Private Partnerships: Work closely with hotels, airlines, and other key players in the tourism ecosystem to ensure coordinated recovery efforts.
- Tourism Boards: Collaborate with local tourism boards to align recovery strategies with marketing initiatives and traveler incentives.

II) Execution Teams

Execution Strategy: Analyze disaster impacts on tourism metrics (e.g., air travel, occupancy rates) and employment trends. Also, prioritize forecasting models (SARIMA, regression) to predict recovery scenarios and future resilience.

Steps to Follow

- Collect and clean updated datasets for disasters, tourism, and jobs.
- Conduct exploratory data analysis to uncover trends and anomalies.
- Recreate or refine forecasting and regression models to evaluate performance metrics (e.g., MSE, R^2).
- Simulate disaster vs. non-disaster scenarios to assess impacts on key metrics.
- Provide actionable insights based on findings for disaster recovery and resilience planning

Key Considerations

- Ensure dataset quality and completeness; address missing values or inconsistencies.
- Monitor model accuracy and adjust parameters to avoid overfitting or underfitting.
- Be prepared for unexpected events (e.g., new disasters, economic changes) that may affect outcomes.

B) Conclusion

Summary of Key Findings

Disaster Impacts

- Natural disasters significantly disrupt Hawaii's tourism metrics, including occupancy rates, air travel, and visitor expenditures, leading to declines in employment within the accommodation and food service sectors.
- Government jobs demonstrate resilience, providing economic stability during crises.

Seasonal Trends

- December and March emerge as peak periods for tourism, driven by holiday demand. Conversely, off-peak periods show vulnerabilities in job and revenue stability.
- Seasonal fluctuations and disaster impacts compound the economic instability of the tourism sector.

Recovery Patterns

- Recovery times vary across metrics: occupancy rates stabilize within 12–18 months, while financial indicators such as ADR and RevPAR take longer (18–24 months).
- Regional disparities highlight faster recovery in Oahu compared to other counties like Hawaii Island, which face prolonged impacts due to infrastructure and economic vulnerabilities.

Economic Drivers

Occupancy rates and air travel are the strongest predictors of job recovery in tourism-related sectors, while visitor expenditures show limited direct impact on employment growth.

Alignment with Problem Statement

The findings directly address the challenges outlined in the problem statement:

- **Understanding Disaster Impacts:** The project successfully quantified the negative effects of disasters on tourism and employment, identifying critical metrics like occupancy rates and air travel that require stabilization for economic recovery.

- **Employment Trends: T**he analysis highlighted the vulnerability of jobs in the accommodation and food service sectors during disruptions, aligning with the need for targeted strategies to protect these roles.
- **Recovery and Resilience:** By examining historical recovery patterns and applying predictive modeling, the project provides actionable insights to guide rapid disaster recovery and long-term economic resilience in Hawaii's tourism sector.
- **Data-Driven Solutions:** The recommendations, rooted in rigorous data analysis, fill the gap in existing frameworks by offering specific, actionable strategies tailored to Hawaii's unique challenges.

Through these insights, the project bridges the gap between high-level disaster recovery plans and the need for a tailored, data-driven framework, ensuring stakeholders are equipped to foster economic stability and sustainability

C) Challenges and Limitations

Data Gaps and Constraints: The analysis was limited by inaccessible data from a FEMA report, which restricted the ability to examine financial recovery funds in detail. Additionally, gaps in county-level data and missing values required adjustments in scope and statistical imputations, reducing the granularity and depth of insights.

Issues Faced During Analysis: Significant challenges included addressing extensive missing data and ensuring data cleanliness, which impacted the robustness of the analysis. Modeling global economic factors proved difficult due to their complexity and limited data representation. Predicting the impact of natural disasters was constrained by their inherent unpredictability, allowing only historical seasonal trends to be captured.

Lessons Learned: The project highlighted the importance of securing comprehensive datasets and adopting efficient data cleaning practices. Key takeaways included enhanced skills in time series analysis and managing large datasets. The analysis reinforced the critical role of tourism in Hawaii's economy, emphasizing its dual impact on business profitability and job market stability, especially during peak seasons.

References

Hawaii Department of Business, Economic Development & Tourism. (n.d.). https://dbedt.hawaii.gov/economic/

See attached Excel Files and codes