**Guided Capstone Project Report – Big Mountain Resort Ticket Price Analysis**

1. **Problem Statement**
   * Big Mountain Resorts (BMR) operates a large ski resort near Glacier National Park that is appropriate for all skiers. Currently, they base their ticket pricing on a comparison to the average price of resorts in its market segment. By taking a more data driven approach and comparing to data from other resorts across the segments, it may be possible to increase profits by pricing more appropriately (i.e., higher) and/or shut down services, thus saving costs, without impacting ticket sales.
   * This analysis seeks to **identify opportunities for Big Mountain Resort to increase profits by 10% over the next ski season through increasing ticket prices, shutting down services that will not impact customer ticket purchases, or a combination of both.**
2. **Analysis:** to address and find solutions to the above problem I executed the following steps.
   * **Data Wrangling:** 
     1. Collected raw data provided by BMR containing information regarding 27 features at 330 resorts (including BMR).
     2. Modified the data set by removing missing values, modifying data entries that were clearly incorrect, and adding data related to the states in which each of the resorts resides to get more information about the local geographies and populace.
     3. After these modifications the dataset included information regarding 25 features at 277 resorts (including BMR)
     4. Decided to focus the analysis using Adult Weekend Ticket prices as the target variable since Adult Weekday prices had more missing values.
   * **Exploratory Data Analysis:**
     1. Augmented the ski resort data to show how each resort contributes to the state ski scene and to gain more insight into how these features may impact prices. Specifically added the following data points: resort skiiable area / state total skiiable area, resort days open / state total days open, number of resort terrain parks / total number of state terrain parks, resort night skiing area / state total night skiing area, total chairs / total runs, total chairs / total skiiable area, total fast quads / total runs, total fast quads / total skiiable area
     2. Assessed statewide data to determine if there were any patterns which could narrow down the geographic focus of the analysis. No clear pattern emerged, so all states were included.
     3. Created a heatmap to assess which features correlate most highly with Adult Weekend Ticket prices (see Figure 1 below). For our target variable - Adult Weekend ticket prices - snow making area, number of runs, fast quads, and vertical drop were the most positively correlated.
     4. Created scatter plots of each variable vs. ticket price. These scatter plots confirmed the positive correlations identified in the heatmap.
   * **Preprocessing and Training:**
     1. **Built and optimized two models (linear regression and random forest)** and compared their results against the baseline of using the mean ticket price as a predictor. The models produced the following performance:

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| **Model:** | **Baseline – Mean Price** | **Linear Regression** | **Random Forest** |
| Mean Absolute Error (MAE) | $19.14 | $10.50 | $9.64 |
| MAE Std Dev | - | $1.62 | $1.35 |

* + 1. **Selected the random forest model** - using the medians to impute missing values without scaling - as the best performing model. This model produced a mean absolute error of $9.64 which was slightly better than the linear regression model and much better than the baseline comparison. It also exhibited lower error variability.
    2. **Determined that fast quads, # runs, snow making ac, and vertical drop were the most important features in determining ticket price (See Figure 2).** This was consistent with both the linear regression and random forest models.
    3. Determined that no additional data is needed for this model as model performance seems to level off at around 50 data points **(see Figure 3).**

1. **Pricing recommendation, scenario modeling, and conclusion**
   * **Pricing recommendation:** Based on the above model using the full data set as inputs (excluding BMR data) **BMR could support an Adult Weekend ticket price increase to $95.87** (+/- $10.39)**.** This represents a percentage increase of 18% above the current ticket price of $81.
     1. Even considering the range of error in the analysis of +/- $10.39, BMR could at least support a price increase to $85.50 which represents a 5.5% increase above the current price.
     2. This would put BMR near the top of the range of ticket prices compared to its national competitors and make it a further outlier in terms of pricing for its Montana market **(see Figures 4 and 5).**
   * **Scenario modeling**
     1. Four BMR feature modification scenarios were modeled to predict their potential impact on BMR’s ticket prices and revenue. **Of the four proposed modifications, the analysis suggests that increasing the vertical drop by adding a run and chair without additional snow making is the most likely to provide the largest profit increases.**

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| **#** | **Feature Modification Scenario** | **Ticket Price Impact** | **Seasonal Revenue Impact** | **Directional Cost Impact** |
| **1** | Permanently closing down up to 10 of the least used runs | $0 (1 run)  -$1.75 (10 runs) | $0 (1 run)  -$3M (10 runs) | ↓ |
| **2** | Increase the vertical drop by adding a run to a point 150 feet lower down but requiring the installation of an additional chair lift to bring skiers back up, without additional snow making coverage. | +$1.99 | +$3.47M | ↑ |
| **3** | Same as number 2, but adding 2 acres of snow making coverage. | +$1.99 | +$3.47M | ↑↑ |
| **4** | Increase the longest run by 0.2 mile to boast 3.5 miles length, requiring an additional snow making coverage of 4 acres. | $0 | $0 | ↑ |

* + **Conclusion: Based on the features of the ski resort, BMR should consider raising ticket prices for the upcoming season while adding an additional run / chair to increase the vertical drop (#2 in table above).** This price increase would be sustainable in the national market. Some major items BMR should consider while raising prices include:
    1. Customer segmentation and communication: it is important to note that BMR is already charging the highest prices in Montana. If BMR’s ownership has information that most of its customers originate from Montana vs. coming from around the country, price increases may not be as palatable to its customer base. This analysis did not consider BMR’s customer segmentation.
    2. Simultaneously pursuing infrastructure enhancements: BMR should simultaneously pursue the feature addition #2 as indicated in the table above. This will help support the price increase and will serve to make the price increase more acceptable to BMR’s customer base. If customers see that the price increases are directly contributing to infrastructure enhancements there is less likelihood of there being a negative perception of the price increase.

1. **Follow on work:**
   * Conduct stakeholder interviews with BMR team to identify other areas of opportunity for revenue generation.
   * Other potential data sets can be gathered / analyzed to provide more specific and detailed recommendations:
     1. number of visitors to other resorts per season
     2. average length of runs in each resort
     3. Customer segmentation data (how many customers are local vs. travel to the resort etc)
     4. ticket types available and breakdown of customers using ski passes vs. daily tickets (many customers now purchase ski passes and don't buy day tickets - this could greatly impact our projected revenue increase)
     5. historical data regarding ticket price increases and facility enhancements
     6. feature usage data (e.g., how many customers use each chair lift, etc)
   * Create a web app with the random forest model so BMR can perform scenario modeling independently.

**Figure 1:** Ski Resort data correlation heatmap

A screenshot of a computer screen

Description automatically generated

**Figure 2:** Random Forest Model Feature Importance

**A graph with blue and white text

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**Figure 3:** Cross-Validation Score as training data set size increases

A graph of training set size

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**Figure 4:** Adult Weekend ticket prices for resorts in market share

A graph of a number of tickets

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**Figure 5:** Adult Weekend ticket prices for resorts in market share **- Montana only**

A graph with blue lines

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