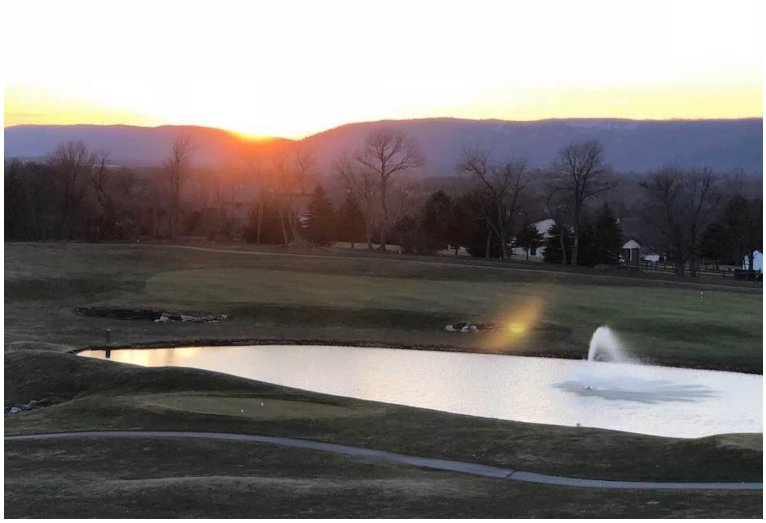

ANALYSIS OF SKI RESORT PROFITABILITY

THE CALC BOYS

ABSTRACT

Skiing and snowboarding are some of the most popular sports during the wintertime. However, climate change has presented challenges to this industry. This project takes a deeper dive into current challenges and potential solutions

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2021 MODELING FOR THE FUTURE CHALLENGE PROJECT REPORT

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Executive Summary

Skiing and snowboarding are some of the most popular sports during the wintertime. It has an estimated market size of $3.5 billion for 2021 with an expected growth of 37.1% in 2021 However, because of climate change with lesser snowfall, many ski resort owners are struggling to attract customers during the wintertime. This results in revenue loss and eventually forces ski-resorts to close their business. To mitigate this problem, ski resort owners have started looking at innovative options, for e.g. artificial snow machines to lessen dependence on nature. This way they can exercise more control and consistently attract customers during the winter season.

We specifically analyzed three resorts in the Rocky Mountain region: Vail, Intrawest, and Arapahoe. We needed data on two areas: Weather and Financials.

Using the past data from the National Centers For Environmental Information (NOAA), we selected four factors that we wanted to study and establish a relationship between Revenue vs snowfall and in turn a relationship between snowfall and snow depth with elevation, average minimum temperature, terrain. However, since the data represented an inconsistent relationship between the parameters we limited ourselves to the basic variables - snowfall and revenue. It is a sequence model that can be used for time series tasks such as ours because snowfall patterns are temporal. Based on data availability, to be more specific we could model snowfall data for the last 10 years on a monthly basis. This would help us predict future snowfall in the winter months. Based on the predicted snowfall value we can analyze the revenue. The relationship for this will be determined by a separate model,(simple neural network, regression).

Data on revenue, profit or financial statements were not publicly available for most resorts and specifically the ones under consideration, as many corporations are either private or part of a larger conglomerate. As such, we continued to pursue other sources of data including government tax records, surveys from the United States Department of Commerce, and even the archives from past years. Despite these large areas for data we were severely restricted due to the large private corporations who chose not to share their data. As a result, we were forced to begin

to parse a variety of data sources to derive some sort of time correlation such that it could be considered as reliable data.

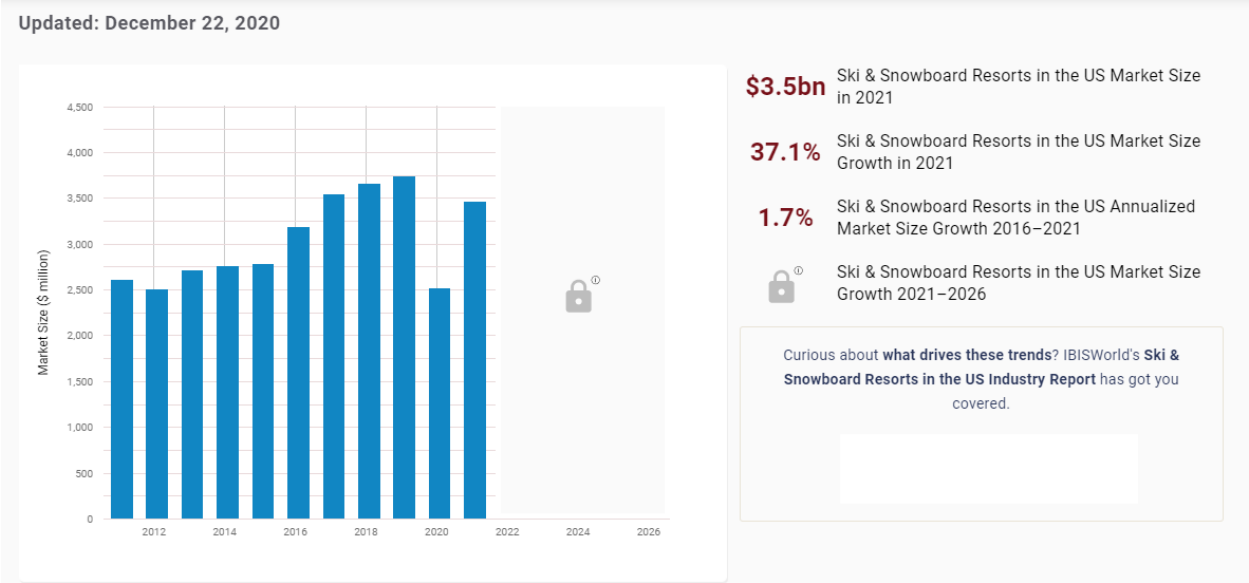
Sources such as NCFEI(National Centers For Environmental Information) and SEC.gov(U.S Securities And Exchange Commision) aided us in finding the types of weather patterns big resorts such as the following three have faced over the past 10 years as well as find profit data on the following resorts.

Our methodology relies on the fact that both snowfall type and the revenue earned are correlated and with that being said , the results from the model prove the fact that our hypothesis is inconclusive. Our prior method of mitigating this was comparing the profit with the amount of snowfall but once again due to insufficient data availability that route too had to be abandoned.

Despite the hindering effect of private capitalism on data sources for this specific project we faced in creating a finishing work product, we were able to establish the methodology and analyze the results in a conclusive manner.

Background Information

Skiing and snowboarding are some of the most popular sports during the wintertime but one of the most nature dependent industries. While it had a revenue of 139 billion dollars alone in 2019, climate change has posed a threat to many ski resort owners who are struggling to attract customers during the wintertime as there is less snowfall. Revenue loss followed by closure is a natural outcome. To mitigate this problem, ski resort owners are looking for more dependable alternatives viz. artificial snow machines to ensure enough snow for the ski slopes and continue attracting more customers during the winter season.



Mathematical modeling

Data Methodology

The primary data points we were trying to capture were snowfall, revenue, snow depth, and temperature. Our primary data sources were NOAA(National Centers For Environmental Information) for the environmental factors such as snow depth, temperature, and snowfall. For revenue trends, we used Macro Trends and USAREC(United States Securities and Exchange Commission), to find out the revenue for each of the ski resorts for the respective years we were studying.

When looking for data, we also had to take the mergers and acquisitions of ski resorts into account when comparing the revenue to the environmental parameters. Keeping within the bounds of the environmental concerns and the scope of the project the group chose to take on, it was extremely limited in terms of data availability. The group was able to create a variety of datasets, though in an inefficient manner, by parsing a variety of basic sources to show some sort of correlation between the independent and dependent variable. Not only does this show a large amount of importance the group placed on strengthening datasets but it also shows the credibility of the data. Being from a variety of sources, the data has a limited chance to be skewed or

incorrect in any way. Thus this time-consuming method of parsing data together proved to strengthen our data. Furthermore, insight into some potential research such as specific profit data broken down by the corporation. These datasets would shed light and help prove our hypothesis regarding risk mitigation and the benefits of certain programs such as artificial snow machines. Without this information finding datasets became a difficult and tedious task that required the parsing method.

Below is an overview of the different sources that we used including the data points and measurements that was explored during the analysis

NOAA Climate Data Archive Daily Summaries (Supporting Data Set)

Scope and Parameters of Data: Daily snowfall, snowfall depth, min and max temperature sourced from Climate Data Online archives of the NOAA specific to the specific to zip codes in the Rocky mountain region for the period 01-Jan-2010 to 31-Dec-2020 .

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Purpose of data: Snowfall and temperature data is extracted as time series data , then used for first identifying relationships with revenue and then Forecasting.

Revenue Data

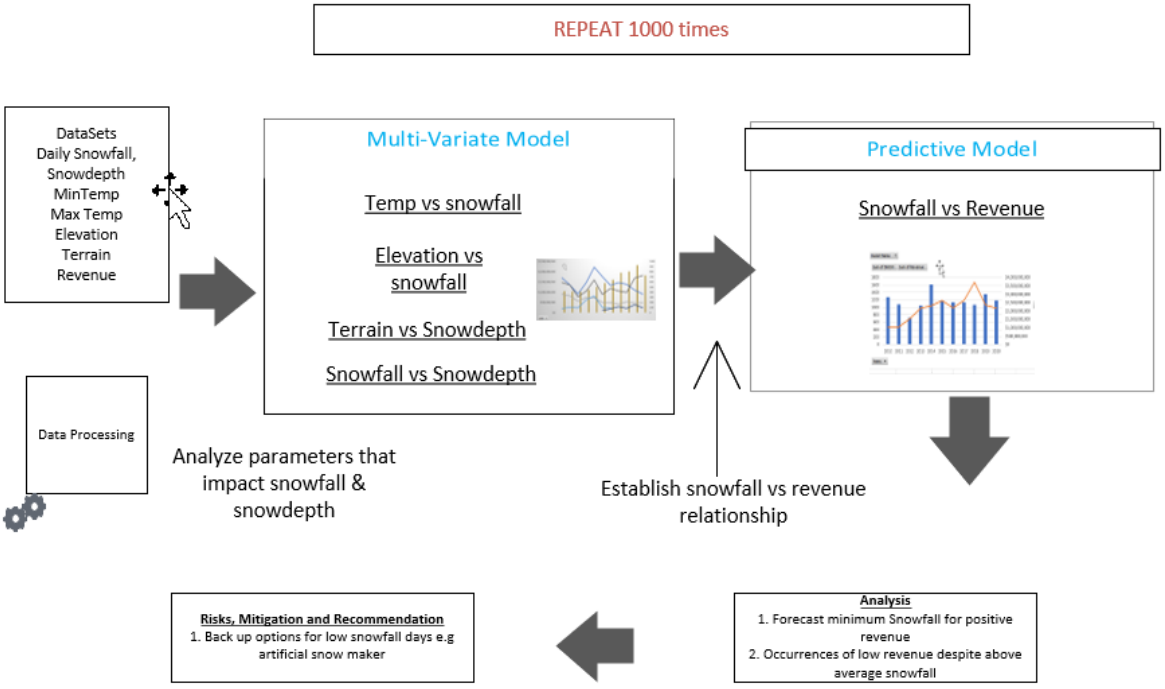
Scope and Parameters of Data: Total Revenue from 10K reports for the same period as weather data - 2010 to 2020

Purpose of the data: the total revenue was used to remove any data bias because of resort specific depreciations, operating costs etc.

Mathematical Modelling

Below is a visual representation of the methodology, with the key steps marked

sequentially

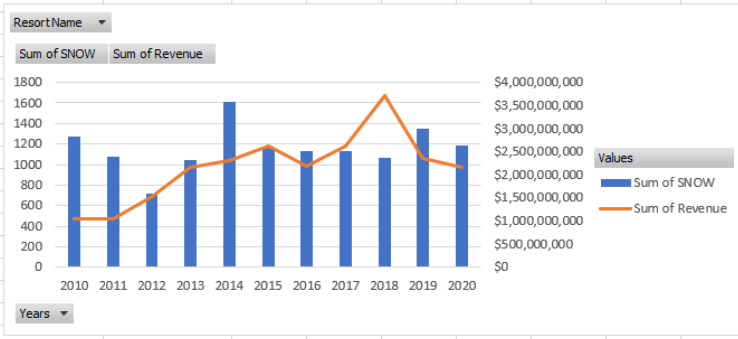


To summarize, after the initial data cleanup and processing of basic trends, the team completed the multivariate analysis with different combinations of the dependent variables to establish the correlation between snowfall and temperature and elevation. Finally the relationship of Revenue vs snowfall. Identifying gaps where revenue was lower with above average snowfall and associating it with extraneous factors to build a consistent story.

Simple Trend Analysis

Resort Name (All)

Years	Values Sum of SNOW	Sum of Revenue
2010	1269.1	$1,055,000,000
2011	1079.1	$1,042,000,000
2012	713.2	$1,533,147,000
2013	1043.5	$2,172,676,000
2014	1614.5	$2,309,506,000
2015	1159.3	$2,621,178,000
2016	1133.9	$2,174,912,000
2017	1135.6	$2,616,800,000
2018	1065.9	$3,702,151,663
2019	1348.4	$2,347,346,800
2020	1183.4	$2,167,310,000
Grand Total	12745.9	$23,742,027,463



Regression Analysis

Regression Statistics

Multiple R	0.95750464
R Square	0.916815135
Adjusted R Square	0.816815135
Standard Error	5755161518
Observations	11

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3.6505E+19	3.6505E+19	110.2141756	2.38E-06
Residual	10	3.31219E+18	3.31219E+17		
Total	11	3.98172E+19			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
snowfall	1547015.233	147358.7272	10.49829394	1.01613E-06	1218679.527	1875350.938	1218679.527	1875350.938

RESIDUAL OUTPUT

Observation	*Predicted Sum of Revenue*	*Residuals*	*Standard Residuals*
1	1963317032	-908317032	-1.655298356
2	1669384138	-627384137.8	-1.143332004
3	1103331264	429815735.9	0.783287394
4	1614310395	35527604.52	0.064744779
5	2497656093	-713403093.4	-1.300091187
6	1793454759	240134240.6	0.437615722
7	1754160573	420751427.5	0.766768784
8	1756790498	526609501.6	0.95968237
9	1648963537	912036463.3	1.662076572
10	2085995340	234004660	0.4264453
11	1830737827	-2737826.554	-0.004989359
11	1931856457	-103856457.5	-0.263792871
11	1785910232	42089768.3	0.126103189

PROBABILITY OUTPUT

Percentile	*Sum of Revenue*
4.545454545	1042000000
13.63636364	1055000000
22.72727273	1533147000
31.81818182	1649838000
40.90909091	1784253000
50	1828000000
59.09090909	2033589000
68.18181818	2174912000
77.27272727	2283400000
86.36363636	2320000000
95.45454545	2561000000
95.45454545	2561000000
95.45454545	2561000000

Multiple Ski resorts, snowfall, snow depth, temp impact on Revenue .

R-squared was very low < 0.30

Significance F was very high > .005

Single ski-resort and looking at the snowfall and the impact on the revenue

R Squared more reasonable: 0.916

Significance F is significantly low: 2.38376839802864E-06

Our data table shows snowfall data for four resorts from 2010-2020, however, revenue data for all VAIL. Over this time span Vail acquired numerous resorts. Hence snowfall and revenue data is not a 1:1 . There is no single source that gives revenue to snowfall data side by side.

Analysis

Though there are many risk factors that are associated with ski resorts such as injuries or damages to infrastructure, overarching solutions such as insurance and snow blowing machines can mitigate the chance of damages exponentially. Insurance would primarily be placed to prevent any mass damages to the equipment that would disable or cause losses to the business while also ensuring these companies are protecting from any mishaps or injuries that may occur regardless of those who are at fault. Additionally, with global warming weather has been increasingly unpredictable for ski resorts. Hence to simply rely on the weather and reports is not an option, thus the implementation of artificial snow machines may allow for some sort of guarantee that resorts will be able to function and have the necessary facilities and needs to attract tourists. However, regardless of how many solution are implemented to try to mitigate risk and prevent large losses for ski resorts, it remains nearly impossible to prevent large natural disasters such as avalanches which may damage the infrastructure of the resort, blizzards which may limit access and safety of the mountains, and earthquakes which could severely injure or damage the structural integrity of the resort itself.

The limited data couldn't be used conclusively to arrive at the desired results. However, the team did use the different data analysis techniques to step through the analysis sequentially, which reaffirmed the data quality issue and the lack thereof.

Conclusion

Overall, we were unable to analyze the data points we wanted to because of the lack of data availability. Overall, these kinds of data sets were very private and were next to impossible to

find. If there was more data available, we would've been able to conduct different types of data analyzes but because of the lack of data, there was a limited number of models we could create. We were unable to prove our hypothesis that ski resort profitability does get adversely impact because of climate changes and snowfall predictability. Hence alternative solutions for artificial snow machine is essential for the sustenance of this high GDP industry.

Appendix

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We are deeply grateful to the following people for helping us through this journey.

We want to thank our coach, Barnali Ghosh and our mentor, Zane Meraz
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Last but not the least we would like to thank the Actuarial foundation for creating such exciting learning opportunities. Because of this project we got a deeper understanding of the power and utility of data, statistical analysis. It also made us start considering actuary as a career option.

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